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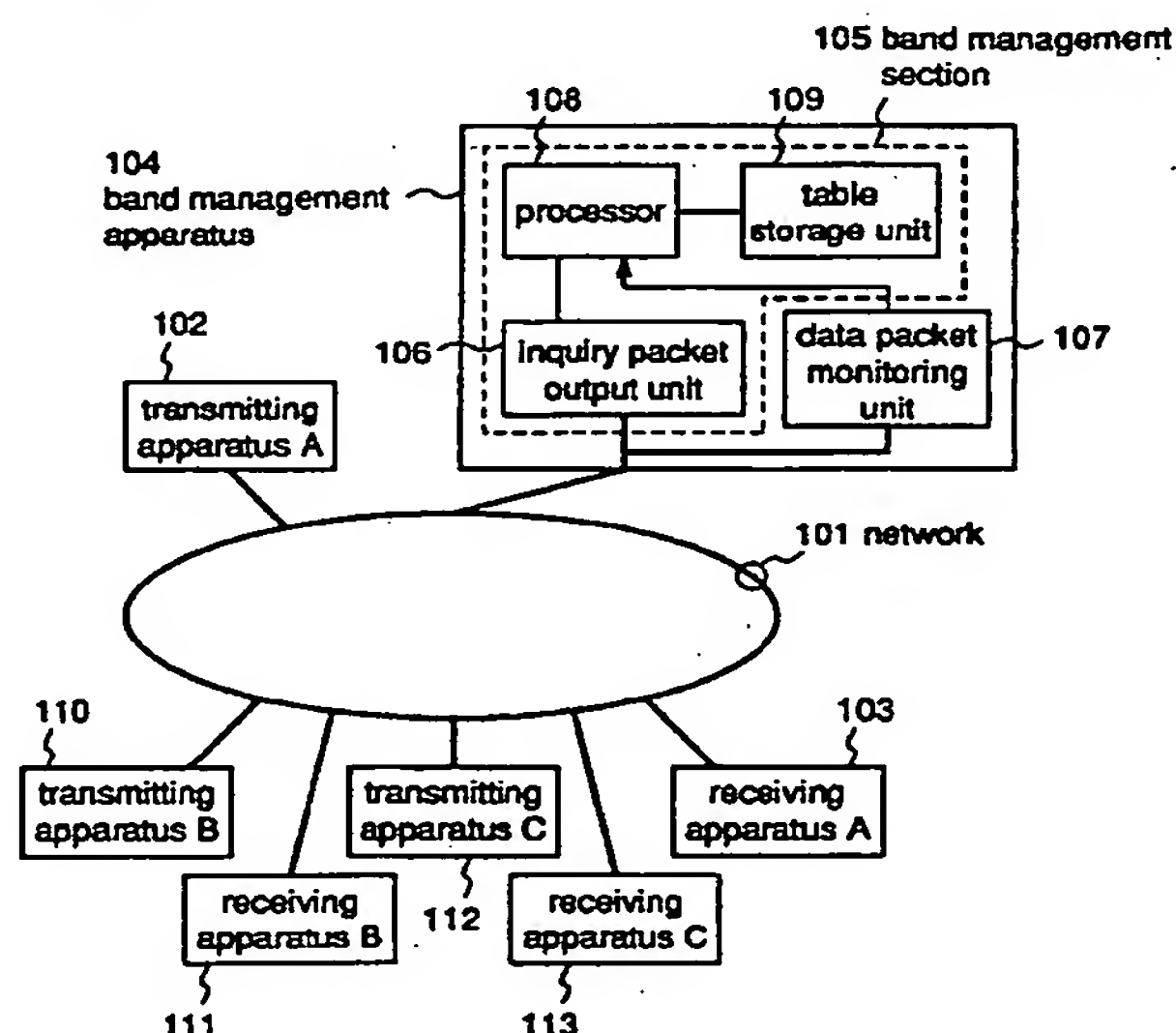
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(54) **Network system, band management apparatus, transmitting apparatus, network transmitting method, band management method, and transmitting method**

(57) A network system which includes at least one of transmitting apparatuses (102,110,112) connected to a network (101) for outputting packets containing data thereto and at least one of receiving apparatuses (103,111,113) connected to the network (101) for receiving the packets thereon which have been output from the transmitting apparatuses, the transmitting apparatuses and the receiving apparatuses making up plural transmitting/receiving systems, comprises data packet monitoring means (107) for monitoring the packets transmitted through the network and detecting the amount of data in the packets to be used in a specified transmitting/receiving system; and band management means (105) for determining a bandwidth on the network to be used in one of the specified transmitting/receiving system and another transmitting/receiving system, based on the amount of data in the packets which is detected by the data packet monitoring means.

Fig.1



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Description

FIELD OF THE INVENTION:

[0001] The present invention relates to a network system, a band management apparatus, a transmitting apparatus, a network transmitting method, a band management method, and a transmitting method, for network data transmission.

BACKGROUND OF THE INVENTION:

[0002] In recent years, systems for transmitting various types of data through a network have been widely used. One method for managing a bandwidth of a band used in plural transmitting/receiving systems uses a band management apparatus.

[0003] Figure 10 shows a network system which uses the band management apparatus according to a prior art. Turning now to figure 10, reference numeral 101 designates a network, 102 designates a transmitting apparatus A, 103 designates a receiving apparatus A, 1004 designates a conventional band management apparatus, 1005 designates a conventional band management section, 106 designates an inquiry packet output unit, 1008 designates a conventional processor, 109 designates a table storage unit, 110 designates a transmitting apparatus B, 111 designates a receiving apparatus B, 112 designates a transmitting apparatus C, and 113 designates a receiving apparatus C. Figure 11 shows a table for managing the number of packets. Hereinafter, a description will be given with reference to figures 10 and 11.

[0004] The table storage unit 109 holds the table shown in figure 11. The processor 108 sequentially reads a transmission source identifier (ID) and a receiving destination ID of a packet to be transmitted on the network from the table storage unit 109 and posts them to the inquiry packet output unit 106. The number of lines is a finite number, i.e., "N" (N: positive integer), as can be seen from the table. The IDs are sequentially read in ascending order of 1-N, and when IDs on the N-th line have been read, the same reading operation is repeated. The inquiry packet output unit 106 adds the posted IDs to an inquiry packet, and outputs the resulting inquiry packet. The transmitting apparatuses A102, B110, and C112, and receiving apparatuses A103, B111, and C113 respectively monitor the inquiry packet all the time. When a receiving apparatus recognizes a match between the receiving destination ID of the inquiry packet and its own ID, it prepares for receiving a data packet which will be output toward the network 101 after a specified time elapses. When a transmitting apparatus recognizes a match between the transmission source ID of the inquiry packet and its own ID, it packetizes data to-be-transmitted and then outputs the packetized data toward the network 101 after a specified time elapses. The receiving apparatus receives the

packet and thereby receives the data from the transmitting apparatus. Then, the inquiry packet output unit 106 outputs a next inquiry packet. Thereafter, the operation is repeated in the same manner.

[0005] Each transmitting/receiving system uses the packets according to information contained in the table storage unit 109, and thereby the band management unit 1004 ensures the number of packets to-be-allocated for each transmitting/receiving system, i.e., a bandwidth to-be-allocated for each transmitting/receiving apparatus.

[0006] Figure 12 shows an example of a table into which information about bandwidth allocation is entered. In figure 12, the number of lines on the table "N" is 6. Assume that a total bandwidth is 6Mbps in the whole network system.

[0007] When transmission between the transmitting apparatus A and the receiving apparatus A requires 3Mbps, as can be seen from the table in figure 12, three out of six are allocated for them. Likewise, when transmission between the transmitting apparatus B and the receiving apparatus B requires 2Mbps, two out of six are allocated for them, and when transmission between the transmitting apparatus C and the receiving apparatus C requires 1Mbps, one out of six is allocated for them. The allocation positions in the table are arbitrary. In this manner, the bandwidth to-be-allocated for each transmitting/receiving system is ensured.

[0008] A description will be given of a case where VBR (variable Bit Rate) data is transmitted from the transmitting apparatus A. In such data transmission, the bandwidth required for the VBR data dynamically changes, and therefore, packets which can be transmitted with the maximum required band are always allocated for the corresponding transmitting/receiving system, or the transmitting apparatus A102 posts the required bandwidth to the band management apparatus 1004, which dynamically changes the bandwidth to-be-allocated.

[0009] Figure 13 is a flowchart showing a procedure for dynamically allocating the number of packets according to the prior art. In Step 1304, the transmitting apparatus A102 decides whether or not the bandwidth to-be-allocated should be changed. When decided that it should be changed, in Step 1305, the transmitting apparatus A102 posts a change request to the band management apparatus 1004. In Step 1302, the band management apparatus 1004 which has received the change request rewrites the contents of the table storage unit 109 to change the bandwidth to-be-allocated.

[0010] However, in the method in which the maximum required bandwidth is always allocated for the corresponding transmitting/receiving system, the maximum bandwidth should be ensured for a time period during which a small bandwidth might be necessary. For this reason, although there are free portions in the total bandwidth, another transmitting/receiving system cannot use them, which causes reduced efficiency in the

use of the band. In addition, in the method in which the transmitting apparatus dynamically posts the change request, a procedure for posting the change request must be prepared for.

SUMMARY OF THE INVENTION:

[0011] It is an object of the present invention to provide a network system, a band management apparatus, a transmitting apparatus, a network transmitting method, a band management method, and a transmitting method, wherein a bandwidth can be dynamically changed without the necessity of preparing for a procedure for posting a request for bandwidth change, and thereby efficiency in the use of the band is improved.

[0012] Other objects and advantages of the invention will become apparent from the detailed description that follows. The detailed description and specific embodiments described are provided only for illustration since various additions and modifications within the spirit of and scope of the invention will be apparent to those skill in the art from the detailed description.

[0013] According to a first aspect of the present invention, a network system which includes at least one of transmitting apparatuses connected to a network for outputting packets containing data thereto and at least one of receiving apparatuses connected to the network for receiving the packets thereon which have been output from the transmitting apparatuses, the transmitting apparatuses and the receiving apparatuses making up plural transmitting/receiving systems, comprises: data packet monitoring means for monitoring the packets transmitted through the network and detecting the amount of data in the packets to be used by a specified transmitting/receiving system; and band management means for determining a bandwidth on the network to be used by the specified transmitting/receiving system, based on the amount of data in the packets which is detected by the data packet monitoring means.

[0014] According to a second aspect of the present invention, in the network system of the first aspect, the band management means holds a maximum value and a minimum value of a bandwidth to be allocated for the specified transmitting/receiving system, sets the bandwidth to be allocated for the specified transmitting/receiving system to the minimum value when the amount of data in the packet which is detected by the data packet monitoring means is zero, and sets the bandwidth to the maximum value when the amount of data in the packet is not zero.

[0015] According to a third aspect of the present invention, in the network system of the first aspect, the band management means determines cycles at regular time intervals, and controls the bandwidth to be allocated for the specified transmitting/receiving system according to the amount of data in the packets which is detected by the data packet monitoring means in one cycle.

[0016] According to a fourth aspect of the present invention, in the network system of the third aspect, the band management means adds the amount of data in the packets for the specified transmitting/receiving system which is detected by the data packet monitoring means in one cycle, increase the bandwidth to be allocated for the specified transmitting/receiving system when the addition result is larger than that in a previous cycle, and reduces the bandwidth when the addition result is smaller than that in the previous cycle.

[0017] According to a fifth aspect of the present invention, in the network system of the third aspect, the band management means includes a table showing correspondences between amount of data and allocated bandwidths, adds the amount of data in the packets for the specified transmitting/receiving system which is detected by the data packet monitoring means in one cycle, finds a range in which the added amount of data lies according to the table, and changes the bandwidth according to the table immediately after detecting that the range is different from a range in which added amount of data in a previous cycle lies.

[0018] According to a sixth aspect of the present invention, in the network system of the third aspect, the band management means holds a reference value of averaged amount of data per packet, computes the averaged amount of data per packet from the amount of data in the packets for the specified transmitting/receiving system which is detected by the data monitoring means in one cycle, increases the bandwidth to be allocated for the specified transmitting/receiving system when the computed averaged amount of data is not smaller than the reference value, and reduces the bandwidth when the computed averaged is smaller than the reference value.

[0019] According to a seventh aspect of the present invention, in the network system of the third aspect, the band management means holds a reference value of the amount of data per packet, increases the bandwidth to be allocated for the specified transmitting/receiving system when the amount of data in the last packet for the specified transmitting/receiving system which is detected by the data packet monitoring means in one cycle is not smaller than the reference value, and reduces the bandwidth when the amount of data is smaller than the reference value.

[0020] According to an eighth aspect of the present invention, in the network system as defined in any of the third to seventh aspects, the transmitting apparatus comprises a data input unit for inputting data; a buffer for temporarily storing data input from the data input unit; and a packet creating unit for controlling the amount of data to be written onto a packet according to the amount of data stored in the buffer when the data is read from the buffer and written onto the packet, and the resulting packet is output toward the network.

[0021] According to a ninth aspect of the present invention, in the network system of the eighth aspect,

the packet creating unit holds an upper limit value of the amount of data to be written onto the packet and a threshold of the amount of data to be stored in the buffer, and writes data of the amount of the upper limit value or more onto the packet when the amount of data to be stored in the buffer is not smaller than the threshold, and the band management apparatus, immediately after detecting at least one packet containing data of the amount of the upper limit value or more for the specified transmitting/receiving system per cycle, sets the bandwidth to be allocated for the specified transmitting/receiving system to a maximum value.

[0022] According to a tenth aspect of the present invention, in the network system as defined in any of third to eighth aspects, the band management means holds an averaged upper limit value of data contained in a packet, and sets the bandwidth to be allocated for the specified transmitting/receiving system to a maximum value immediately after the averaged amount of data per packet for the specified transmitting/receiving system in one cycle has become the averaged upper limit value or more.

[0023] According to an eleventh aspect of the present invention, in a network system which includes at least one of transmitting apparatuses connected to a network for outputting packets containing data thereto and at least one of receiving apparatuses connected to the network for receiving the packets thereon which have been output from the transmitting apparatuses, the transmitting apparatuses and the receiving apparatuses making up plural transmitting/receiving systems, a band management apparatus for managing a bandwidth on the network system used by at least one of the transmitting/receiving systems, comprises a data packet monitoring unit for monitoring the packets transmitted through the network and detecting the amount of data in the packets to be used by a specified transmitting/receiving system; and a band management unit for determining a bandwidth on the network to be used by the specified transmitting/receiving system, based on the amount of data in the packets which is detected by the data packet monitoring unit.

[0024] According to a twelfth aspect of the present invention, in the band management apparatus of the eleventh aspect, the band management unit holds a maximum value and a minimum value of a bandwidth to be allocated for the specified transmitting/receiving system, sets the bandwidth to be allocated for the specified transmitting/receiving system to the minimum value when the amount of data in the packet is zero, and sets the bandwidth to the maximum value when the amount of data in the packet is not zero.

[0025] According to a thirteenth aspect of the present invention, in the band management apparatus of the eleventh aspect, the band management unit determines cycles at regular time intervals, and controls the bandwidth to be allocated for the specified transmitting/receiving system according to the amount of data in

the packets which is detected by the data packet monitoring unit in one cycle.

[0026] According to a fourteenth aspect of the present invention, in the band management apparatus of the thirteenth aspect, the band management unit adds the amount of data in the packets which is detected by the data packet monitoring unit in one cycle, increases the bandwidth to be allocated for the specified transmitting/receiving system when the addition result is larger than that in a previous cycle, and reduces the bandwidth when the addition result is smaller than that in the previous cycle.

[0027] According to a fifteenth aspect of the present invention, in the band management apparatus of the thirteenth aspect, the band management unit includes a table showing correspondences between amount of data and allocated bandwidths, adds the amount of data in the packets which is detected by the data packet monitoring unit in one cycle, finds a range in which the added amount of data lies according to the table, and changes the bandwidth according to the table immediately after detecting that the range is different from a range in which added amount of data in a previous cycle lies.

[0028] According to a sixteenth aspect of the present invention, in the band management apparatus of the thirteenth aspect, the band management unit holds a reference value of averaged amount of data per packet, computes the averaged amount of data per packet from the amount of data in the packets which is detected by the data packet monitoring means in one cycle, increases the bandwidth to be allocated for the specified transmitting/receiving system when the computed averaged amount of data is not smaller than the reference value, and reduces the bandwidth when the computed averaged amount of data is smaller than the reference value.

[0029] According to a seventeenth aspect of the present invention, in the band management apparatus of the thirteenth aspect, the band management unit holds a reference value of the amount of data per packet, increases the bandwidth to be allocated for the specified transmitting/receiving system when the amount of data in the last packet for the specified transmitting/receiving system which is detected by the data packet monitoring unit in one cycle is not smaller than the reference value, and reduces the bandwidth when the amount of data is smaller than the reference value.

[0030] According to an eighteenth aspect of the present invention, in the band management apparatus as defined in any of twelfth to seventeenth aspects, the band management unit, immediately after detecting at least one packet containing data of the amount of the upper limit value or more for the specified transmitting/receiving system per cycle, sets the bandwidth to be allocated for the specified transmitting/receiving system to the maximum value.

[0031] According to a nineteenth aspect of the present

invention, in the band management apparatus as defined in any of the twelfth to seventeenth aspects, the band management unit holds an averaged upper limit value of data contained in a packet, and sets the bandwidth to be allocated for the specified transmitting/receiving system to the maximum value immediately after the averaged amount of data per packet for the specified transmitting/receiving system has become the averaged upper limit value or more.

[0032] According to a twentieth aspect of the present invention, a transmitting apparatus connected to a network for outputting a packet containing data thereto, comprises: a data input unit for inputting data; a buffer for temporarily storing data input from the data input unit; and a packet creating unit for controlling the amount of data to be written onto a packet according to the amount of data stored in the buffer when the data is read from the buffer and written onto the packet, and the resulting packet is output toward the network.

[0033] According to a twenty-first aspect of the present invention, in the transmitting apparatus of the twentieth aspect, the packet creating unit holds an upper limit value of the amount of data to be written onto a packet and a threshold of the amount of data to be stored in the buffer, and writes data of the amount of the upper limit value or more onto the packet when the amount of data to be stored in the buffer is not smaller than the threshold.

[0034] According to a twenty-second aspect of the present invention, a network transmitting method in a network system which includes at least one of transmitting apparatuses connected to a network for outputting packets containing data thereto and at least one of receiving apparatuses connected to the network for receiving the packets thereon which have been output from the transmitting apparatuses, the transmitting apparatuses and the receiving apparatuses making up plural transmitting/receiving systems, comprises monitoring the packets transmitted through the network, detecting the amount of data in the packets to be used by a specified transmitting/receiving system, and determining a bandwidth on the network to be used by the specified transmitting/receiving system, based on the detected amount of data.

[0035] According to a twenty-third aspect of the present invention, the network transmitting method of the twenty-second aspect further comprises setting the bandwidth to be allocated for the specified transmitting/receiving system to the minimum value when the amount of data is zero, and setting the bandwidth to the maximum value when the amount of data is not zero.

[0036] According to a twenty-fourth aspect of the present invention, the network transmitting method of the twenty-second aspect further comprises determining cycles at regular time intervals each comprising at least one packet, and controlling the bandwidth to be allocated for the specified transmitting/receiving system according to the amount of data for the specified system

per cycle.

[0037] According to a twenty-fifth aspect of the present invention, the network transmitting method of the twenty-fourth aspect further comprises increasing the bandwidth to be allocated for the specified transmitting/receiving system when the amount of data per cycle is larger than the amount of data in a previous cycle, and reducing the bandwidth when the amount of data per cycle is smaller than the amount in the previous cycle.

[0038] According to a twenty-sixth aspect of the present invention, the network transmitting method of the twenty-fourth aspect further comprises holding a table showing correspondences between amount of data and allocated bandwidths, computing the amount of data for the specified transmitting/receiving system per cycle, and finding the bandwidth to be allocated which is adapted to the amount of data according to the table.

[0039] According to a twenty seventh aspect of the present invention, the network transmitting method of the twenty fourth aspect further comprises holding a reference value of averaged amount of data, computing the averaged amount of data for the specified transmitting/receiving system per cycle, increasing the bandwidth to be allocated for the specified transmitting/receiving system when the computed averaged amount of data is not smaller than the reference value, and reducing the bandwidth when the computed averaged amount is smaller than the reference value.

[0040] According to a twenty-eighth aspect of the present invention, the network transmitting method of the twenty-fourth aspect further comprises holding a reference value of the amount of data per packet, increasing the bandwidth to be allocated for the specified transmitting/receiving system when the detected amount of data in the last packet for the specified transmitting/receiving system in one cycle is not smaller than the reference value, and reducing the bandwidth when the detected amount is smaller than the reference value.

[0041] According to a twenty-ninth aspect of the present invention, the network transmitting method as defined in any of the twenty-fourth to twenty-eighth aspects further comprises controlling the amount of data to be written onto a packet according to the amount of data stored in transmitting means.

[0042] According to a thirtieth aspect of the present invention, the network transmitting method of the twenty-ninth aspect further comprises, when the transmitting means transmits a packet containing data, determining an upper limit value of the amount of data written onto the packet and a threshold of the amount of data stored in the transmitting means, the transmitting means writing data of the amount of the upper limit value or more onto the packet immediately after storing data of the amount of the threshold or more therein, and setting the bandwidth to be allocated for the specified

transmitting/receiving system to the maximum value when at least one packet containing data of the amount exceeding the upper limit value on the network is detected in one cycle.

[0043] According to a thirty-first aspect of the present invention, the network transmitting method as defined in any of the twenty-fourth to twenty-ninth aspects, further comprising determining an averaged upper limit value of the amount of data contained per packet, and immediately after the amount of data per packet for the specified transmitting/receiving system in one cycle has become the averaged upper limit value or more, setting the bandwidth to be allocated for the specified transmitting/receiving system to the maximum value.

[0044] According to a thirty-second aspect of the present invention, in a network system which includes at least one of transmitting apparatuses connected to a network for outputting packets containing data thereto and at least one of receiving apparatuses connected to the network for receiving the packets thereon which have been output from the transmitting apparatuses, the transmitting apparatuses and the receiving apparatuses making up plural transmitting/receiving-systems, a band management method for managing a bandwidth on the network used by at least one of the transmitting/receiving systems, comprises: monitoring the packets transmitted through the network, detecting the amount of data in the packets to be used by a specified transmitting/receiving system, and determining a bandwidth on the network to be used by the specified transmitting/receiving system, based on the detected amount of data.

[0045] According to a thirty-third aspect of the present invention, the band management method of the thirty-second aspect further comprises setting the bandwidth to be allocated for the specified transmitting/receiving system to the minimum value when the amount of data is zero, and setting the bandwidth to the maximum value when the amount of data is not zero.

[0046] According to a thirty-fourth aspect of the present invention, the band management method of the thirty-second aspect further comprises determining cycles at regular time intervals each comprising at least one packet, and controlling the bandwidth to be allocated for the specified transmitting/receiving system according to the amount of data for it per cycle.

[0047] According to a thirty-fifth aspect of the present invention, the band management method of the thirty-fourth aspect further comprises increasing the bandwidth to be allocated for the specified transmitting/receiving system when the amount of data per cycle is larger than the amount of data in a previous cycle, and reducing the bandwidth when the amount of data per cycle is smaller than the amount in the previous cycle.

[0048] According to a thirty-sixth aspect of the present invention, the band management method of the thirty-fourth aspect further comprises holding a table showing

correspondences between amount of data and allocated bandwidths, computing the amount of data to be allocated for the specified transmitting/receiving system per cycle, and finding the bandwidth to be allocated which is adapted to the amount of data according to the table.

[0049] According to a thirty-seventh aspect of the present invention, the band management method of the thirty-fourth aspect further comprises holding a reference value of the averaged amount of data, computing the averaged amount of data for specified transmitting/receiving system per cycle, increasing the bandwidth to be allocated for the specified transmitting/receiving system when the averaged amount of data is not smaller than the reference value, and reducing the bandwidth when the averaged amount is smaller than the reference value.

[0050] According to a thirty-eighth aspect of the present invention, the band management method of the thirty-fourth aspect further comprises holding a reference value of the amount of data per packet, increasing the bandwidth to be allocated for the specified transmitting/receiving system when the detected amount of data in the last packet for the specified transmitting/receiving system in one cycle is not smaller than the reference value, and reducing the bandwidth when the detected amount is smaller than the reference value.

[0051] According to a thirty-ninth aspect of the present invention, the band management method as defined in any of the thirty-fourth to thirty-eighth aspects further comprises determining an upper limit value of the amount of data to be written onto a packet, and setting the bandwidth to be allocated for the specified transmitting/receiving system to the maximum value when at least one packet containing data of the amount exceeding the upper limit value is detected in one cycle.

[0052] According to a forty aspect of the present invention, the band management method as defined in any of thirty-fourth to thirty-eighth aspects further comprises determining an averaged upper limit value of the amount of data contained per packet, and setting the bandwidth to be allocated for the specified transmitting/receiving system to the maximum value immediately after the amount of data contained per packet for the specified system in one cycle has become the averaged upper limit value or more.

[0053] According to a forty-first aspect of the present invention, a transmitting method for transmitting a packet containing data written by a transmitting apparatus connected to a network, comprises: controlling amount of data to be written onto the packet according to the amount of data stored in the transmitting apparatus.

[0054] According to a forty-second aspect of the present invention, the transmitting method of the forty-first aspect, further comprises: when transmitting a packet containing data, determining an upper limit value of the amount of data to be written onto the packet and

a threshold of the amount of data stored in transmitting apparatus, and writing data of the amount of the upper limit value or more immediately after data of the amount of the threshold or more is stored in the transmitting apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0055]

Figure 1 is a diagram showing a network system according to first, second, and third embodiments of the present invention.

Figure 2 is a flowchart showing band management according to the first embodiment of the present invention.

Figures 3(a) and 3(b) are diagrams showing an example of a bandwidth requested by the transmitting apparatus of the first embodiment and showing an example of bandwidth switching performed by the band management apparatus of the first embodiment.

Figure 4 is a flowchart showing bandwidth management according to a second embodiment of the present invention.

Figure 5 is a flowchart showing bandwidth management according to a third embodiment of the present invention.

Figure 6 is a diagram showing an example of an allocation table.

Figure 7 is a diagram showing temporal change of the number of allocated packets according to a third embodiment of the present invention.

Figure 8 is a diagram showing a network system according to a fourth embodiment of the present invention.

Figure 9 is a flowchart showing a process for maximizing a bandwidth according to a fourth embodiment of the present invention.

Figure 10 is a diagram showing a network system according to a prior art.

Figure 11 is a diagram showing a table for managing the number of packets.

Figure 12 is a diagram showing a table for managing the number of packets.

Figure 13 is a flowchart showing a procedure for dynamically allocating the number of packets according to a prior art.

Figure 14 is a diagram showing temporal change of the number of packets according to the second embodiment of the present invention.

Figure 15 is a diagram showing temporal change of the number of packets according to a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT:

Embodiment 1.

[0056] Hereinafter, a description will be given of a first embodiment of the present invention with reference to figure 1. Figure 1 shows a construction of a network system according to the first embodiment of the present invention. In figure 1, reference numeral 101 designates a network, 102 designates a transmitting apparatus A, 103 designates a receiving apparatus A, 104 designates a band management apparatus in the network system of the first embodiment, 105 designates a band management section of the band management apparatus 104, 106 designates an inquiry packet output unit, 107 designates a data packet monitoring unit, 108 designates a processor, 109 designates a table storage unit, 110 designates a transmitting apparatus B, 111 designates a receiving apparatus B, 112 designates a transmitting apparatus C, and 113 designates a receiving apparatus C. In this first embodiment, the transmitting apparatus A 102 and the receiving apparatus A 103 make up a VBR transmitting/receiving system.

[0057] The maximum value and the minimum value of the number of packets to-be-allocated for the VBR transmitting/receiving system are defined as follows. The maximum value is the number of packets which contain data of the maximum rate in the VBR transmitting/receiving system and the minimum value is larger than "0". The processor 108 sequentially reads a transmission source ID and a receiving destination ID of a packet to-be-transmitted on the network, and posts them to the inquiry packet output unit 106. The inquiry packet output unit 106 adds the posted IDs to the inquiry packet and outputs the resulting packet. The transmitting apparatus A102 and the receiving apparatus A103 always monitor the inquiry packet. When the receiving apparatus A103 recognizes a match between the receiving destination ID and its own ID, it prepares for receiving a data packet which will be output to the network after a specified time has elapsed. When the transmitting apparatus A102 recognizes a match between the transmission source ID of the inquiry packet and its own ID, it packetizes data to-be-transmitted and then outputs the packetized data toward the network 101 after a specified time has elapsed. If there is no data to-be-transmitted, the transmitting apparatus A102 outputs an empty packet. The data packet monitoring unit 107 detects the amount of data in this packet. When the packet is empty, the number of packets to-be-allocated for the system is set to the minimum value.

[0058] On the other hand, when there is data to-be-transmitted, the transmitting apparatus A102 writes the data onto the packet and outputs the resulting packet. The data packet monitoring unit 107, upon detection of the packet onto which the data has been written, sends information indicating this to the processor 108. The

processor 108 rewrites the contents of the table storage unit 109 and sets the number of the packets to the maximum value.

[0059] When the data packet monitoring unit 107 has detected a packet containing no data again, it sends information indicating this to the processor 108. The processor 108 rewrites the contents of the table storage unit 109 and sets the number of packets to the minimum value.

[0060] Figure 2 shows flow of a process for deciding bandwidth switching of the first embodiment. In Step 201, processing is started. In Step 202, the band management apparatus 104 detects a data packet on the network 101. When the detected data packet is a packet for the specified transmitting/receiving system in Step S203, in Step 204, it is decided whether or not the amount of data in the packet has changed from a previous value. When decided that there is no change in Step S204, the number of the packets to be allocated is not changed. On the other hand, when decided that there is some change, it is decided whether or not the value of the amount of data has changed to "0" in Step 205. When decided that it has changed to "0" in Step 205, the content of the table is rewritten so as to set the number of the packets to the minimum value in Step 207, whereas when decided that it has changed to "a value other than 0" in Step 205, the content of the table is rewritten so as to set the number of packets to the maximum value in Step 206.

[0061] Figures 3(a) and 3(b) show an example of bandwidth switching of this embodiment. Figure 3(a) shows an example of a bandwidth which is requested by the transmitting apparatus and figure 3(b) shows an example of bandwidth switching performed by the band management apparatus 104. In figure 3(a), a longitudinal axis indicates a required bandwidth, a lateral axis indicates time, and R_{max} is a bandwidth of generated data. In figure 3(b), a longitudinal axis indicates an allocated bandwidth, a lateral axis indicates time, B_{max} is a maximum value of the allocated bandwidth, and B_{min} is a minimum value of the allocated bandwidth.

[0062] In this illustrated example, at time t_1 , the transmitting apparatus generates data to-be-transmitted. At time t_1 , the value of the allocated bandwidth is B_{min} . When the data to-be-transmitted is generated, the transmitting apparatus A102 outputs a packet containing the data. The band management apparatus 104, immediately after detecting the packet containing the data, i.e., at t_2 , sets the bandwidth to-be-allocated to B_{max} . At time t_3 , the transmitting apparatus A102 need not transmit data and therefore transmits an empty packet. The band management apparatus 104, immediately after detecting the empty packet, i.e., at time t_4 , sets the bandwidth to-be-allocated to B_{min} .

[0063] Thus, in accordance with the first embodiment, the band management apparatus always monitors amount of data contained in the packet for the specified transmitting/receiving system, and when there is no

data, it allocates the smallest number of packets, whereas when there is some data, it allocates the largest number of packets. Thereby, without the necessity of preparing for another procedure for posting the request for bandwidth change, the bandwidth to-be-allocated can be dynamically changed. Data in transition from the detection of the amount of data to the change of the bandwidth, is stored in a buffer with which the transmitting/receiving apparatus is provided. The change of amount of data is directly detected and according to the detection result, the bandwidth to-be-allocated is determined. Therefore, in contrast with processing the request for bandwidth change following another procedure, the response time is improved and fewer buffers are required. The empty bandwidth resulting from the change is used for transmission of another data, i.e., anisochronous data transmission for which the bandwidth need not be strictly ensured. As a result, efficiency in the use of the band is increased while ensuring that the maximum bandwidth is always allocated for the VBR transmitting/receiving system.

[0064] While in the first embodiment the band management apparatus outputs the inquiry packet to which the transmission ID has been added, and thereby controls the number of packets, i.e., the bandwidth to-be-allocated, another method may be employed. For instance, the band management apparatus may post a time table for packets to the transmitting apparatus, and according to the time table, the transmitting apparatus may output the packets. Also in this case, the same effects are provided by detecting amount of data, posting an updated time table to the transmitting apparatus when the amount of data has changed, and changing the bandwidth to-be-allocated by the use of the band management apparatus.

[0065] In addition, while the first embodiment uses one VBR transmitting/receiving system, two or more systems may be implemented in the same manner.

Embodiment 2.

[0066] A description will be given of a network system according to a second embodiment of the present invention.

[0067] The network system of the second embodiment differs from that of the first embodiment in operation of the band management apparatus 104. Hereinafter, the description will be given with reference to figures 1, 4, and 14.

[0068] In this second embodiment, the band management apparatus 104 determines cycles at regular time intervals (one or more packets) (see figure 14). The data packet monitoring unit 107 monitors packets for the specified transmitting/receiving system in the cycles and detects the amount of data in the packets. When all of the detected packets are full, that is, a data storage area in the packet is filled with effective data, the bandwidth to-be-allocated for the specified transmit-

ting/receiving system is increased, otherwise, the bandwidth is reduced. When there is the upper limit value for the bandwidth to-be-allocated and the increased bandwidth exceeds the upper limit value, the value of the allocated bandwidth becomes the upper limit value. When there is the lower limit value for the bandwidth to-be-allocated and the reduced bandwidth is less than the lower limit value, the value of the allocated bandwidth becomes the lower limit value.

[0069] Figure 4 shows a flow of a process for deciding bandwidth switching of the second embodiment. In Step 401, processing is started. In Step 402, the band management apparatus 104 sets Full_Flag to "1". The Full_Flag indicates the presence/absence of the packets which are not full in a cycle. In Step 403, detection of the packet is repeated when the Full_Flag is "1" in the cycle.

[0070] Subsequently in Step 404, a data packet on the network 101 is detected. When the detected data packet is a packet for the specified transmitting/receiving system in Step 405, and the packet is not full in step 406, Full_Flag is set to "0" in Step 407. This operation is repeated until the end of the cycle in step 408.

[0071] Upon completion of the cycle, the Full_Flag is checked in Step 409. When the Full_Flag is "1", the content of the table storage unit 109 is rewritten to increase the bandwidth to-be-allocated. When the increased bandwidth exceeds the upper limit value, the value of the allocated bandwidth becomes the upper limit value, in step 410. On the other hand, when Full_Flag is "0", the content of the table storage unit 109 is rewritten to reduce the bandwidth to-be-allocated. When the reduced bandwidth is less than the lower limit value, the value of the allocated bandwidth becomes the lower limit value in Step 411.

[0072] Figure 14 shows temporal change of the number of the allocated packets. In figure 14, packets represented by oblique lines are packets for the VBR transmitting/receiving system and the others are packets allocated for systems other than the VBR transmitting/receiving system, a lateral axis indicates time, and numerals under the packets allocated for the VBR transmitting/receiving system indicate amount of data in the packets. Here it is assumed that one cycle is a time period for 6 packets and packets are full when the numeral indicates 50.

[0073] The band management apparatus 104 monitors data packets in a cycle for the specified transmitting/receiving system, and in the next cycle, decides the number of packets to-be-allocated. Since there is one data packet allocated for the specified transmitting/receiving system in cycle 1, and the packet is full, in cycle 2, the number of packets for the specified system is set to 2. In cycle 2, these two packets are both full, and therefore in cycle 3, the number of the packets for the specified transmitting/receiving system is set to 3. In cycle 3, since there are data packets for the specified system which are not full, in cycle 4, the number of the

packets for the specified system is set to 2. Thereafter, the same operation is repeated.

[0074] Thus, in accordance with the second embodiment, the band management apparatus always monitors the amount of data in packets for the specified transmitting/receiving system, and according to the amount of data in each cycle, changes the bandwidth to-be-allocated. Thereby, without the necessity of preparing for another procedure for posting the request for bandwidth change, the bandwidth to-be-allocated can be dynamically changed. Data in transition from the detection of the amount of data to the change of the bandwidth, is stored in a buffer with which the transmitting/receiving apparatus is provided. The change of amount of data is directly detected and according to the detection result, the bandwidth to-be-allocated is determined. Therefore, in contrast with processing the request for bandwidth change following another procedure, the response time is improved and fewer buffers are required. The empty bandwidth resulting from the change is used for transmission of another data, i.e., anisochronous data transmission for which the bandwidth need not be strictly ensured. As a result, efficiency in the use of the band is increased while ensuring that the maximum bandwidth is allocated for the VBR transmitting/receiving system.

[0075] The numeric values used in this embodiment is only illustrative and not restrictive.

[0076] While in the second embodiment the band management apparatus outputs the inquiry packet to which the transmission ID has been added, and thereby controls the number of packets, i.e., the bandwidth to-be-allocated, another method may be employed. For instance, the band management apparatus may post a time table for packets to the transmitting apparatus, and according to the time table, the transmitting apparatus may output the packets. Also in this case, the same effects are provided by detecting the amount of data, posting an updated time table to the transmitting apparatus when the amount of data has changed, and changing the bandwidth to-be-allocated by the use of the band management apparatus.

[0077] In addition, while in the second embodiment the number of packets is increased/decreased according to the number of packets in one cycle which are full, the last packet allocated for the specified transmitting/receiving system may be detected in one cycle and when it is full, the number of packets may be increased, whereas when it is not full, the number of packets may be decreased, whereby the same effects are obtained.

[0078] Besides, while in the second embodiment the number of packets is increased/decreased by one according to the number of packets in one cycle which are full, the same effects are provided regardless of whether arbitrary number of packets are increased/decreased or the numbers of the increased and reduced packets differ from each other.

[0079] Further, the following methods for increas-

ing/decreasing the number of packets are conceived. One such method is to integrate amount of data for the specified transmitting/receiving system in one cycle, increase the bandwidth to-be-allocated when the integration result is larger than that in a previous cycle, keep the bandwidth unchanged when there is no change between them, and reduce the bandwidth when the result is smaller than or "0". Another such method is to calculate an average of the amount of data per packet detected in one cycle, increase the bandwidth when the average is not smaller than a threshold determined by the system, and reduce the bandwidth when the average is smaller than the threshold. Also in such cases, the same effects are provided regardless of whether arbitrary number of packets are increased/reduced or the numbers of the increased and reduced packets differ from each other.

[0080] Still further, while in the second embodiment, the description has been given of one VBR transmitting/receiving system, two or more systems may be implemented in the same manner.

[0081] Moreover, while in the second embodiment, according to the comparison result of the data amount in a current cycle, the number of packets in a subsequent cycle is determined, the number of packets in a cycle which comes after the subsequent or the following cycle may be determined according to the same.

Embodiment 3.

[0082] A description will be given of a network system according to a third embodiment of the present invention.

[0083] The network system of the third embodiment differs from that of the first and second embodiments in operation of the band management apparatus 104 in figure 1. Hereinafter, a description will be given of the network system of the third embodiment with reference to figures 5, 6, and 7.

[0084] In this third embodiment, the band management apparatus 104 determines cycles at regular time intervals (one or more packets). The band management section 105 holds a table (hereinafter referred to as an allocation table) which contains the number of packets to-be-allocated for data in one cycle.

[0085] Figure 5 shows flow of a procedure for deciding bandwidth switching of this third embodiment. In Step 501, processing is started. In Step 502, the band management apparatus 104 sets an initialization of the amount of cycle data to "0". In Step 503, the data packet on the network 101 is detected. When the detected data packet is a packet for the specified transmitting/receiving system in Step 504, the amount of the packet data is added to the amount of the cycle data in Step 505. In Step 506, this operation is repeated until the end of the cycle.

[0086] Upon completion of the cycle, in step 507, the allocation table is referred to determine the number of

the packets to-be-allocated from the amount of cycle data. When there is some change between the number of packets in a current cycle and the number of packets in a previous cycle in Step 508, in Step 509, the content in the table storage unit 109 is rewritten to change the number of packets. On the other hand, when there is no change between them, in Step 510, the number of packets remains unchanged.

[0087] Subsequently, a description will be given of processing data. Figure 6 shows an example of the allocation table. As can be seen from the table, the packet allocation is as follows. When the amount of data in the detected packet is 0-50, 51-100, 101-151, and 151-200, one packet, two packets, three packets, and four packets are allocated for the transmitting/receiving system per cycle, respectively.

[0088] How the table is used will be described below with reference to figure 7. Figure 7 shows temporal change of the number of allocated packets according to this embodiment.

[0089] In figure 7, packets represented by oblique lines are packets for the VBR transmitting/receiving system and the others are packets allocated to systems other than the VBR transmitting/receiving system, a lateral axis indicates time, and numerals under the packets allocated for the VBR transmitting/receiving system indicate amount of data in the packets. Here it is assumed that one cycle is a time period for 6 packets.

[0090] Since the amount of cycle data in cycle 1 is 55, it is decided that the number of the packets to-be-allocated in cycle 2 is "2" according to the table in figure 6. Likewise, since the amount of cycle data in cycle 2 is 110, it is decided that the number of packets to-be-allocated in cycle 3 is "3" according to the table in figure 6. Thereafter, in a like manner, the number of packets in the corresponding cycle is decided according to the table.

[0091] Thus, in accordance with the third embodiment, the band management apparatus always monitors the amount of data in the packet in the transmitting/receiving systems, and by referring to the table according to the increase/decrease in the amount of data between cycles, the bandwidth to-be-allocated is changed. Thereby, without the necessity of preparing for another procedure for posting the request for bandwidth change, the bandwidth to-be-allocated can be dynamically changed. Data in transition from the detection of the amount of data to the change of the allocated bandwidth, is stored in a buffer with which the transmitting/receiving apparatus is provided. The change of amount of data is directly detected and according to the detection result, the bandwidth to-be-allocated is determined. Therefore, in contrast with processing the request for bandwidth change following another procedure, the response time is improved and fewer buffers are required. The empty bandwidth resulting from the change is used for transmission of another data, i.e., anisochronous data transmission for which the band-

width need not be strictly ensured. As a result, efficiency in the use of the band is increased while ensuring that the maximum bandwidth is always allocated for the VBR transmitting/receiving system.

[0092] While in the third embodiment, the band management apparatus outputs the inquiry packet to which the transmission ID has been added, and thereby controls the number of packets, i.e., the bandwidth to be allocated, another method may be employed. For instance, the band management apparatus may post a time table for packets to the transmitting apparatus, and according to the time table, the transmitting apparatus may output the packets. Also in this case, the same effects are provided by detecting amount of data, posting an updated time table to the transmitting apparatus when the amount of data has changed, and changing the bandwidth to-be-allocated by the use of the band management apparatus.

[0093] While in the third embodiment, the number of packets to-be-allocated for data in one cycle is entered into the table, the number of packets to-be-allocated for the average of the amount of data (per packet) may be entered into it. In this case, the average is found in each cycle and according to the table, the number of packets is changed.

[0094] In addition, while the third embodiment uses one VBR transmitting/receiving system, two or more systems may be implemented in the same manner.

[0095] Moreover, while in the third embodiment, the number of packets in a subsequent cycle is determined with reference to the table, the number of packets in a cycle which comes after the subsequent or the following cycle may be determined with reference to the same.

Embodiment 4.

[0096] A description will be given of a network system according to a fourth embodiment of the present invention. The fourth embodiment differs from the above embodiments in that the rate at which data is output from a transmitting apparatus rapidly increase. This will be described with reference to figures 8, 9, and 15.

[0097] Figure 8 shows a network system of the fourth embodiment. In figure 8, reference numerals 101 designates a network, 802 designates a transmitting apparatus A, 103 designates a receiving apparatus A, 804 designates a band management apparatus, 805 designates a band management section, 106 designates an inquiry packet output unit, 807 designates a data packet monitoring unit, 808 designates a processor, 109 designates a table storage unit, 810 designates a data generation source, 811 designates a buffer, 812 designates a packet creating unit, 813 designates a buffer monitoring unit, 110 designates a transmitting apparatus B, 111 designates a receiving apparatus B, 112 designates a transmitting apparatus C, and 113 designates a receiving apparatus C. In this fourth embodiment, the transmitting apparatus A 802 and the receiving apparatus

A103 makes up the VBR transmitting/receiving system.

[0098] The processor 808 sequentially reads a transmission source ID and a receiving destination ID of a packet to be transmitted on the network, and posts them to the inquiry packet output unit 106. The inquiry packet output unit 106 adds the posted IDs to the inquiry packet and outputs the resulting packet. The transmitting apparatus A802 and the receiving apparatus A103 always monitor the inquiry packet. When the receiving apparatus A103 recognizes a match between the receiving destination ID and its own ID, it prepares for receiving a data packet which will be output to the network after a specified time has elapsed. When the transmitting apparatus A102 recognizes a match between the transmission source ID of the inquiry packet and its own ID, it packetizes data to-be-transmitted and then outputs the packetized data toward the network 101 after a specified time has elapsed. Data to-be-written is output from the data generation source 810 and is temporarily stored in the buffer 811 at an arbitrary rate. The packet creating unit 812 reads data from the buffer 811 and writes data onto the packet.

[0099] In this fourth embodiment, the packet creating unit 812 holds the upper limit value of the amount of data to be written per packet. It should be remembered that the amount of data does not exceed this upper limit value in normal transmission. The buffer monitoring unit 813 monitors the amount of data to be stored in the buffer and posts it to the packet creating unit 812. The packet creating unit 812 holds a threshold and when the posted data amount has exceeded the threshold, it writes data of the amount exceeding the upper limit value into the packet.

[0100] A description will be given of operation of the band management apparatus 804 of this embodiment.

[0101] The band management apparatus 804 determines cycles at regular time intervals (one or more packets). The data packet monitoring unit 807 detects amount of data in packets for the transmitting/receiving system. When the monitoring unit 807 has detected one or more packets (hereinafter referred to as an upper limit value packet) which contain data of the amount of the upper limit value or more in a cycle, the number of packets to-be-allocated for the specified transmitting/receiving system is set to a maximum value immediately.

[0102] Figure 9 shows flow of such bandwidth maximizing process. In Step 901, processing is started. In Step 902, the band management apparatus 104 sets the number of the upper limit value packets to "0", and in Step 903, it detects a data packet on the network 101. When the detected packet is a packet for the specified transmitting/receiving system and the amount of the packet data is not smaller than the upper limit value in Step 904, the number of the upper limit value packets is increased by "1" in step 905. This operation is repeated until the end of the cycle in Step 906.

[0103] Upon completion of the cycle, in Step 907, it is

decided whether or not the number of the upper limit value packets is not smaller than a specified value. When decided that the number is not smaller than the specified value, in Step 908, the content of the table storage unit is rewritten and the bandwidth to-be-allocated is set to the maximum value. When decided that the number is smaller than the specified value, in step 909, the same processing performed in any of the first, second, and third embodiments is carried out.

[0104] Figure 15 shows temporal change of the number of allocated packets according to this embodiment.

[0105] In figure 15, packets represented by oblique lines are packets for the VBR transmitting/receiving system and the others are packets allocated for systems other than the VBR transmitting/receiving system, a lateral axis indicates time, and numerals under the packets allocated for the VBR transmitting/receiving system indicate amount of data in the packets. Here it is assumed that one cycle is a time period for 6 packets, and the specified number of the upper limit value packets, the upper limit value, and the maximum value of the packets to-be-allocated are "1", "90", and "4", respectively. The packet allocation is performed according to the table in figure 6 except that at the detection of the upper limit value packets.

[0106] Since the amount of cycle data is "90" in cycle 1, the number of the packets to-be-allocated is "2" in cycle 2 according to the table. In cycle 2, the number of the upper limit value packets is "2", and is not smaller than the specified number, so that the number of the packets to-be-allocated in cycle 3 is "4" (maximum value).

[0107] Thus, in accordance with the fourth embodiment, the band management apparatus determines the upper limit value of the amount of data in the packet for the specified transmitting/receiving system, the data of the amount exceeding the upper limit value being written onto the packet when the amount of data stored in the buffer of the transmitting apparatus has exceeded the specified threshold, and sets the bandwidth to the maximum value immediately after detecting the packets containing data of the amount exceeding the upper limit value of the specified number or more in one cycle. The operation of the band management apparatus improves response of the bandwidth change for the case where the data rate rapidly changes.

[0108] While in the fourth embodiment the band management apparatus outputs the inquiry packet to which the transmission ID has been added, and thereby controls the number of packets, i.e., the bandwidth to-be-allocated, another method may be employed. For instance, the band management apparatus may post a time table for packets to the transmitting apparatus, and according to the time table, the transmitting apparatus may output the packets. Also in this case, the same effects are provided by detecting amount of data, posting an updated time table to the transmitting apparatus

when the amount of data has changed, and changing the bandwidth to be allocated by the use of the band management apparatus.

[0109] While in the fourth embodiment the number of the packets to-be-allocated is set to the maximum value immediately after detecting the packet containing data of the amount of the upper limit value or more which is not smaller than the specified number, the band management apparatus may determine an averaged upper limit value, compute the average amount (per packet) in a cycle, and set the number of packets to-be-allocated to the maximum value immediately after the average has become the averaged upper limit value or more.

[0110] In addition, the number of packets to-be-allocated may be set to be the maximum value immediately after one packet containing data of the amount of the upper limit value or more is detected.

[0111] While in the fourth embodiment rapid increase in the rate of the transmitting apparatus is detected according to the threshold of the amount of data in the buffer, a rate measurement device may be connected to a data input unit for detecting rapid increase in the rate which is to be posted to the packet creating unit.

[0112] Besides, while the fourth embodiment uses one VBR transmitting/receiving system, two or more systems may be implemented in the same manner.

[0113] Further, while in the fourth embodiment, the number of packets is set to the maximum value in a subsequent cycle, this may be performed in a cycle which comes after the subsequent or the following cycle.

[0114] As should be appreciated from the foregoing description, in accordance with the present invention, in the network system where the band management apparatus manages the bandwidth to be used in each transmitting/receiving system, the band management apparatus monitors amount of data in the packets for the specified transmitting/receiving system, and increases/reduces the bandwidth to-be-allocated for the specified transmitting/receiving system according to increase/decrease in the amount of data. Thereby, it is possible to dynamically change bandwidth allocation without the necessity of preparing another procedure for posting the request for bandwidth change and thereby improve the efficiency in the use of the band.

Claims

1. A network system which includes at least one of transmitting apparatuses connected to a network for outputting packets containing data thereto and at least one of receiving apparatuses connected to the network for receiving the packets thereon which have been output from the transmitting apparatuses, the transmitting apparatuses and the receiving apparatuses making up plural transmitting/receiving systems, said network system comprising:

data packet monitoring means for monitoring the packets transmitted through the network and detecting the amount of data in the packets to be used by a specified transmitting/receiving system; and

band management means for determining a bandwidth on the network to be used by the specified transmitting/receiving system, based on the amount of data in the packets which is detected by the data packet monitoring means.

2. The network system as defined in Claim 1 wherein, the band management means holds a maximum value and a minimum value of a bandwidth to be allocated for the specified transmitting/receiving system, sets the bandwidth to be allocated for the specified transmitting/receiving system to the minimum value when the amount of data in the packet which is detected by the data packet monitoring means is zero, and sets the bandwidth to the maximum value when the amount of data is not zero.
3. The network system as defined in Claim 1 wherein, the band management means determines cycles at regular time intervals, and controls the bandwidth to be allocated for the specified transmitting/receiving system according to the amount of data in the packets which is detected by the data packet monitoring means in one cycle.
4. The network system as defined in Claim 3 wherein, the band management means adds the amount of data in the packets for the specified transmitting/receiving system which is detected by the data packet monitoring means in one cycle, increase the bandwidth to be allocated for the specified transmitting/receiving system when the addition result is larger than that in a previous cycle, and reduces the bandwidth when the addition result is smaller than that in the previous cycle.
5. The network system as defined in Claim 3 wherein, the band management means includes a table showing correspondences between amount of data and allocated bandwidths, adds the amount of data in the packets for the specified transmitting/receiving system which is detected by the data packet monitoring means in one cycle, finds a range in which the added amount of data lies according to the table, and changes the bandwidth according to the table immediately after detecting that the range is different from a range in which added amount of data in a previous cycle lies.
6. The network system as defined in Claim 3 wherein, the band management means holds a reference value of averaged amount of data per packet, computes the averaged amount of data per packet from

the amount of data in the packets for the specified transmitting/receiving system which is detected by the data monitoring means in one cycle, increases the bandwidth to be allocated for the specified transmitting/receiving system when the computed averaged amount of data is not smaller than the reference value, and reduces the bandwidth when the computed averaged is smaller than the reference value.

7. The network system as defined in Claim 3 wherein, the band management means holds a reference value of the amount of data per packet, increases the bandwidth to be allocated for the specified transmitting/receiving system when the amount of data in the last packet for the specified transmitting/receiving system which is detected by the data packet monitoring means in one cycle is not smaller than the reference value, and reduces the bandwidth when the amount of data is smaller than the reference value.
8. The network system as defined in any of Claims 3 to 7 wherein the transmitting apparatus comprises a data input unit for inputting data; a buffer for temporarily storing data input from the data input unit; and a packet creating unit for controlling the amount of data to be written onto a packet according to the amount of data stored in the buffer when the data is read from the buffer and written onto the packet, and the resulting packet is output toward the network.
9. The network system as defined in Claim 8 wherein the packet creating unit holds an upper limit value of the amount of data to be written onto the packet and a threshold of the amount of data to be stored in the buffer, and writes data of the amount of the upper limit value or more onto the packet when the amount of data to be stored in the buffer is not smaller than the threshold, and the band management apparatus, immediately after detecting at least one packet containing data of the amount of the upper limit value or more for the specified transmitting/receiving system per cycle, sets the bandwidth to be allocated for the specified transmitting/receiving system to a maximum value.
10. The network system as defined in any of Claims 3 to 8 wherein, the band management means holds an averaged upper limit value of data contained in a packet, and sets the bandwidth to be allocated for the specified transmitting/receiving system to a maximum value immediately after the averaged amount of data per packet for the specified trans-

mitting/receiving system in one cycle has become the averaged upper limit value or more.

11. In a network system which includes at least one of transmitting apparatuses connected to a network for outputting packets containing data thereto and at least one of receiving apparatuses connected to the network for receiving the packets thereon which have been output from the transmitting apparatuses, the transmitting apparatuses and the receiving apparatuses making up plural transmitting/receiving systems, a band management apparatus for managing a bandwidth on the network system used by at least one of the transmitting/receiving systems, comprising:

a data packet monitoring unit for monitoring the packets transmitted through the network and detecting the amount of data in the packets to be used by a specified transmitting/receiving system; and
a band management unit for determining a bandwidth on the network to be used by the specified transmitting/receiving system, based on the amount of data in the packets which is detected by the data packet monitoring unit.

12. The band management apparatus as defined in Claim 11 wherein

the band management unit holds a maximum value and a minimum value of a bandwidth to be allocated for the specified transmitting/receiving system, sets the bandwidth to be allocated for the specified transmitting/receiving system to the minimum value when the amount of data in the packet is zero, and sets the bandwidth to the maximum value when the amount of data in the packet is not zero.

13. The band management apparatus as defined in Claim 11 wherein

the band management unit determines cycles at regular time intervals, and controls the bandwidth to be allocated for the specified transmitting/receiving system according to the amount of data in the packets which is detected by the data packet monitoring unit in one cycle.

14. The band management apparatus as defined in Claim 13 wherein,

the band management unit adds the amount of data in the packets which is detected by the data packet monitoring unit in one cycle, increases the bandwidth to be allocated for the specified transmitting/receiving system when

the addition result is larger than that in a previous cycle, and reduces the bandwidth when the addition result is smaller than that in the previous cycle.

15. The band management apparatus as defined in Claim 13 wherein

the band management unit includes a table showing correspondences between amount of data and allocated bandwidths, adds the amount of data in the packets which is detected by the data packet monitoring unit in one cycle, finds a range in which the added amount of data lies according to the table, and changes the bandwidth according to the table immediately after detecting that the range is different from a range in which added amount of data in a previous cycle lies.

16. The band management apparatus as defined in Claim 13 wherein,

the band management unit holds a reference value of averaged amount of data per packet, computes the averaged amount of data per packet from the amount of data in the packets which is detected by the data packet monitoring means in one cycle, increases the bandwidth to be allocated for the specified transmitting/receiving system when the computed averaged amount of data is not smaller than the reference value, and reduces the bandwidth when the computed averaged amount of data is smaller than the reference value.

17. The band management apparatus as defined in Claim 13 wherein

the band management unit holds a reference value of the amount of data per packet, increases the bandwidth to be allocated for the specified transmitting/receiving system when the amount of data in the last packet for the specified transmitting/receiving system which is detected by the data packet monitoring unit in one cycle is not smaller than the reference value, and reduces the bandwidth when the amount of data is smaller than the reference value.

18. The band management apparatus as defined in any of Claims 12 to 17 wherein,

the band management unit, immediately after detecting at least one packet containing data of the amount of the upper limit value or more for

the specified transmitting/receiving system per cycle, sets the bandwidth to be allocated for the specified transmitting/receiving system to the maximum value.

19. The band management apparatus as defined in any of Claims 12 to 17 wherein,

the band management unit holds an averaged upper limit value of data contained in a packet, and sets the bandwidth to be allocated for the specified transmitting/receiving system to the maximum value immediately after the averaged amount of data per packet for the specified transmitting/receiving system has become the averaged upper limit value or more.

20. A transmitting apparatus connected to a network for outputting a packet containing data thereto, comprising:

a data input unit for inputting data;
a buffer for temporarily storing data input from the data input unit; and
a packet creating unit for controlling the amount of data to be written onto a packet according to the amount of data stored in the buffer when the data is read from the buffer and written onto the packet, and the resulting packet is output toward the network.

21. The transmitting apparatus as defined in Claim 20 wherein,

the packet creating unit holds an upper limit value of the amount of data to be written onto a packet and a threshold of the amount of data to be stored in the buffer, and writes data of the amount of the upper limit value or more onto the packet when the amount of data to be stored in the buffer is not smaller than the threshold.

22. A network transmitting method in a network system which includes at least one of transmitting apparatuses connected to a network for outputting packets containing data thereto and at least one of receiving apparatuses connected to the network for receiving the packets thereon which have been output from the transmitting apparatuses, the transmitting apparatuses and the receiving apparatuses making up plural transmitting/receiving systems, comprises monitoring the packets transmitted through the network, detecting the amount of data in the packets to be used by a specified transmitting/receiving system, and determining a bandwidth on the network to be used by the specified transmitting/receiving system, based on the detected amount of data.

23. The network transmitting method as defined in Claim 22 further comprising setting the bandwidth to be allocated for the specified transmitting/receiving system to the minimum value when the amount of data is zero, and setting the bandwidth to the maximum value when the amount of data is not zero.

24. The network transmitting method as defined in Claim 22 further comprising determining cycles at regular time intervals each comprising at least one packet, and controlling the bandwidth to be allocated for the specified transmitting/receiving system according to the amount of data for the specified system per cycle.

25. The network transmitting method as defined in Claim 24 further comprising increasing the bandwidth to be allocated for the specified transmitting/receiving system when the amount of data per cycle is larger than the amount of data in a previous cycle, and reducing the bandwidth when the amount of data per cycle is smaller than the amount in the previous cycle.

26. The network transmitting method as defined in Claim 24 further comprising holding a table showing correspondences between amount of data and allocated bandwidths, computing the amount of data for the specified transmitting/receiving system per cycle, and finding the bandwidth to be allocated which is adapted to the amount of data according to the table.

27. The network transmitting method as defined in Claim 24 further comprising holding a reference value of averaged amount of data, computing the averaged amount of data for the specified transmitting/receiving system per cycle, increasing the bandwidth to be allocated for the specified transmitting/receiving system when the computed averaged amount of data is not smaller than the reference value, and reducing the bandwidth when the computed averaged amount is smaller than the reference value.

28. The network transmitting method as defined in Claim 24 further comprising holding a reference value of the amount of data per packet, increasing the bandwidth to be allocated for the specified transmitting/receiving system when the detected amount of data in the last packet for the specified transmitting/receiving system in one cycle is not smaller than the reference value, and reducing the bandwidth when the detected amount is smaller than the reference value.

29. The network transmitting method as defined in any

of Claims 24 to 28 further comprising controlling the amount of data to be written onto a packet according to the amount of data stored in transmitting means.

30. The network transmitting method as defined in Claim 29 further comprising, when the transmitting means transmits a packet containing data, determining an upper limit value of the amount of data written onto the packet and a threshold of the amount of data stored in the transmitting means, the transmitting means writing data of the amount of the upper limit value or more onto the packet immediately after storing data of the amount of the threshold or more therein, and setting the bandwidth to be allocated for the specified transmitting/receiving system to the maximum value when at least one packet containing data of the amount exceeding the upper limit value on the network is detected in one cycle.
31. The network transmitting method as defined in any of Claims 24 to 29 further comprising determining an averaged upper limit value of the amount of data contained per packet, and immediately after the amount of data per packet for the specified transmitting/receiving system in one cycle has become the averaged upper limit value or more, setting the bandwidth to be allocated for the specified transmitting/receiving system to the maximum value.
32. In a network system which includes at least one of transmitting apparatuses connected to a network for outputting packets containing data thereto and at least one of receiving apparatuses connected to the network for receiving the packets thereon which have been output from the transmitting apparatuses, the transmitting apparatuses and the receiving apparatuses making up plural transmitting/receiving systems, a band management method for managing a bandwidth on the network used by at least one of the transmitting/receiving systems, comprising:
 - monitoring the packets transmitted through the network, detecting the amount of data in the packets to be used by a specified transmitting/receiving system, and determining a bandwidth on the network to be used by the specified transmitting/receiving system, based on the detected amount of data.
33. The band management method as defined in Claim 32 further comprising setting the bandwidth to be allocated for the specified transmitting/receiving system to the minimum value when the amount of data is zero, and setting the bandwidth to the maximum value when the amount of data is not zero.
34. The band management method as defined in Claim 32 further comprising determining cycles at regular time intervals each comprising at least one packet, and controlling the bandwidth to be allocated for the specified transmitting/receiving system according to the amount of data for it per cycle.
35. The band management method as defined in Claim 34 further comprising increasing the bandwidth to be allocated for the specified transmitting/receiving system when the amount of data per cycle is larger than the amount of data in a previous cycle, and reducing the bandwidth when the amount of data per cycle is smaller than the amount in the previous cycle.
36. The band management method as defined in Claim 34 further comprising holding a table showing correspondences between amount of data and allocated bandwidths, computing the amount of data to be allocated for the specified transmitting/receiving system per cycle, and finding the bandwidths to be allocated which is adapted to the amount of data according to the table.
37. The band management method as defined in Claim 34 further comprising holding a reference value of the averaged amount of data, computing the averaged amount of data for specified transmitting/receiving system per cycle, increasing the bandwidth to be allocated for the specified transmitting/receiving system when the averaged amount of data is not smaller than the reference value, and reducing the bandwidth when the averaged amount is smaller than the reference value.
38. The band management method as defined in Claim 34 further comprising holding a reference value of the amount of data per packet, increasing the bandwidth to be allocated for the specified transmitting/receiving system when the detected amount of data in the last packet for the specified transmitting/receiving system in one cycle is not smaller than the reference value, and reducing the bandwidth when the detected amount is smaller than the reference value.
39. The band management method as defined in any of Claims 34 to 38 further comprising determining an upper limit value of the amount of data to be written onto a packet, and setting the bandwidth to be allocated for the specified transmitting/receiving system to the maximum value when at least one packet which contains data of the amount exceeding the upper limit value is detected in one cycle.
40. The band management method as defined in any of Claims 34 to 38 further comprising determining an

averaged upper limit value of the amount of data contained per packet, and setting the bandwidth to be allocated for the specified transmitting/receiving system to the maximum value immediately after the amount of data contained per packet for the specified system in one cycle has become the averaged upper limit value or more. 5

41. A transmitting method for transmitting a packet containing data written by a transmitting apparatus connected to a network, comprising: 10

controlling amount of data to be written onto the packet according to the amount of data stored in the transmitting apparatus. 15

42. The transmitting method as defined in Claim 41 further comprising: when transmitting a packet containing data, determining an upper limit value of the amount of data to be written onto the packet and a threshold of the amount of data stored in transmitting apparatus, and writing data of the amount of the upper limit value or more immediately after data of the amount of the threshold or more is stored in the transmitting apparatus. 20 25

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Fig.1

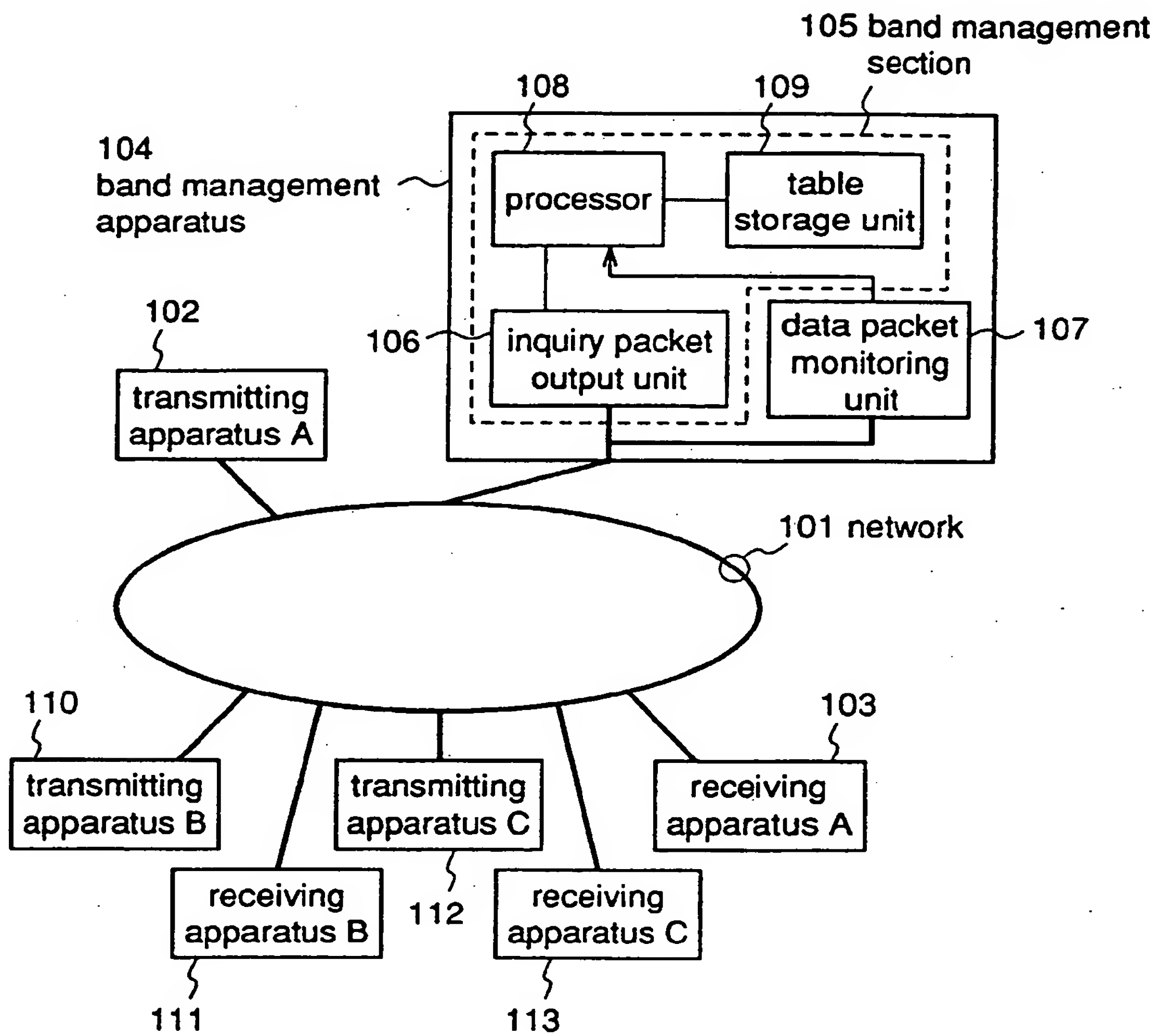


Fig.2

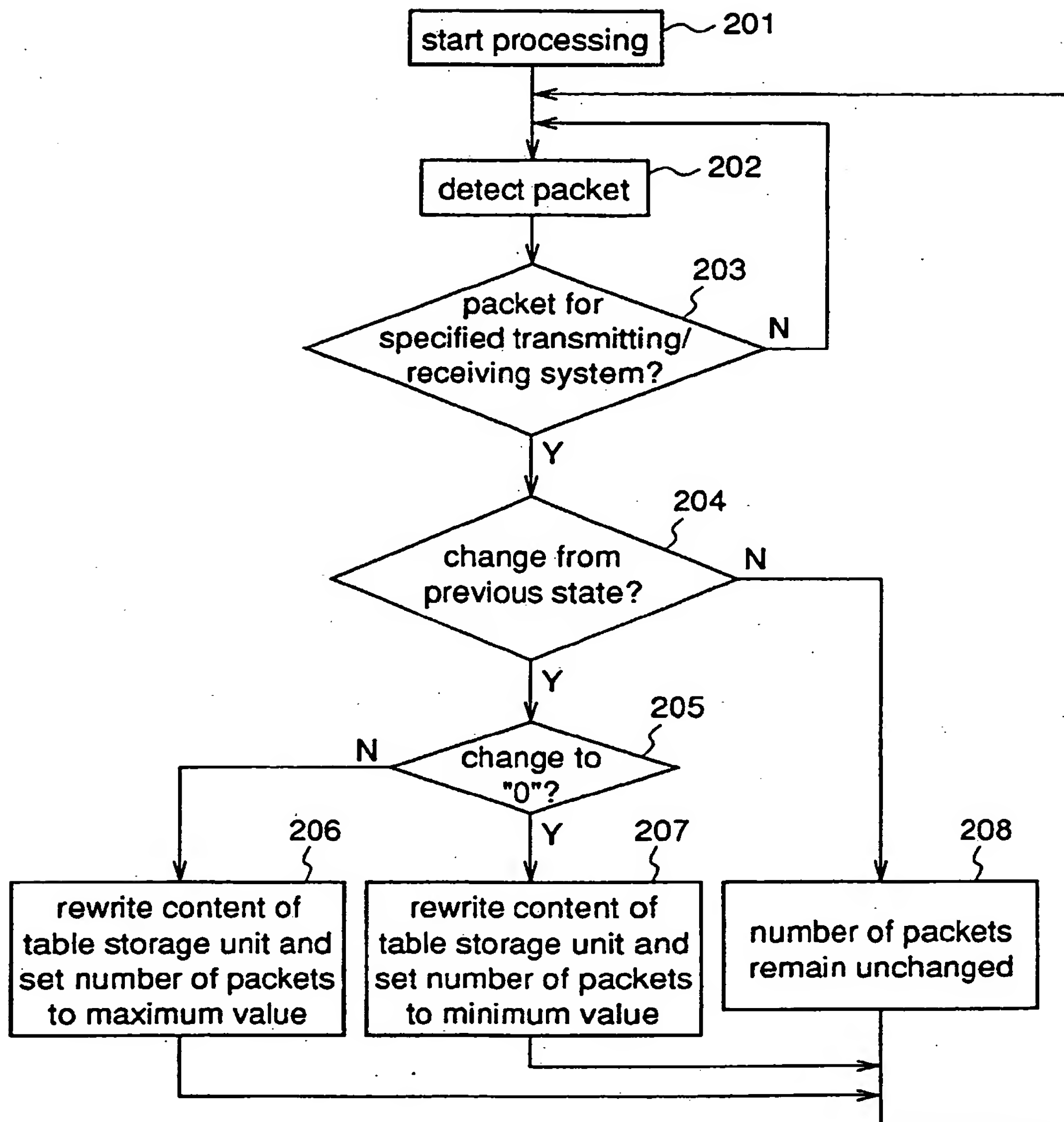


Fig.3 (a)

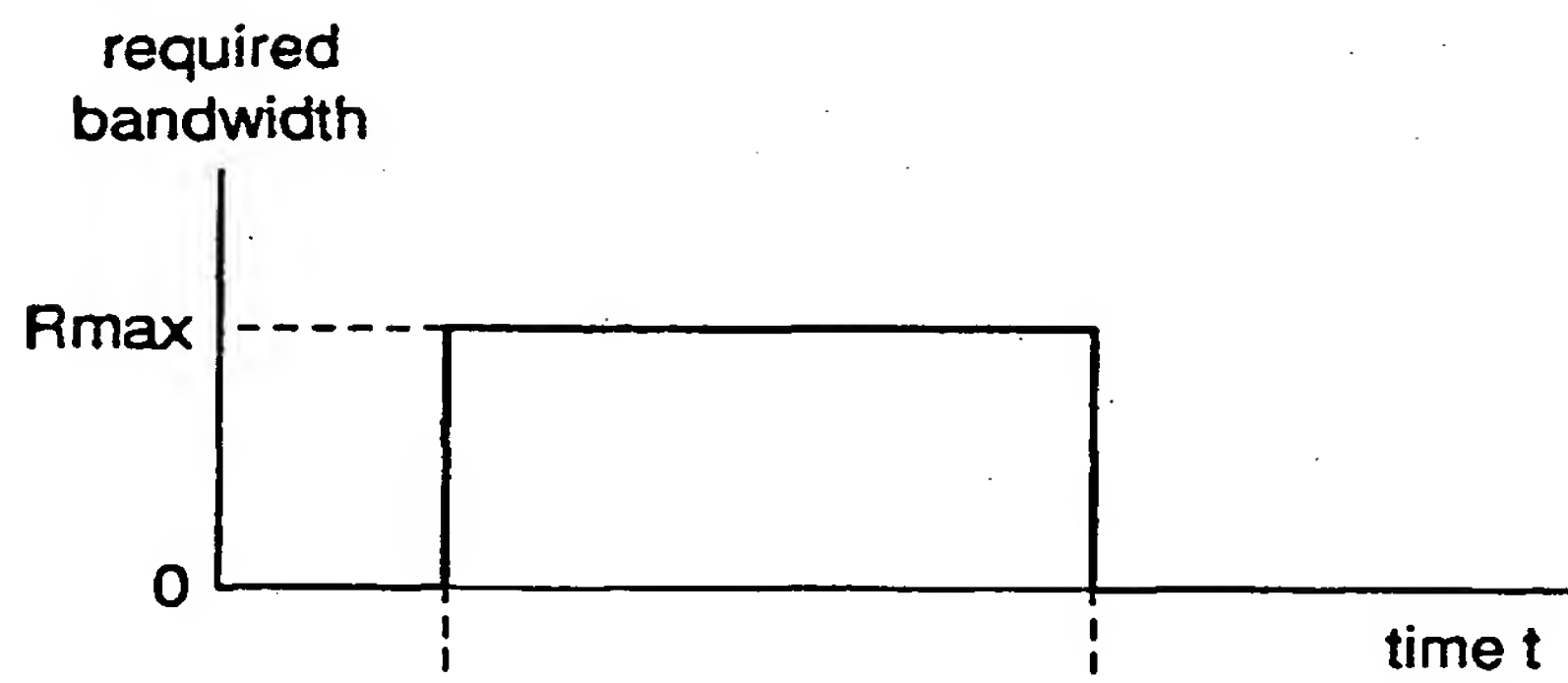


Fig.3 (b)

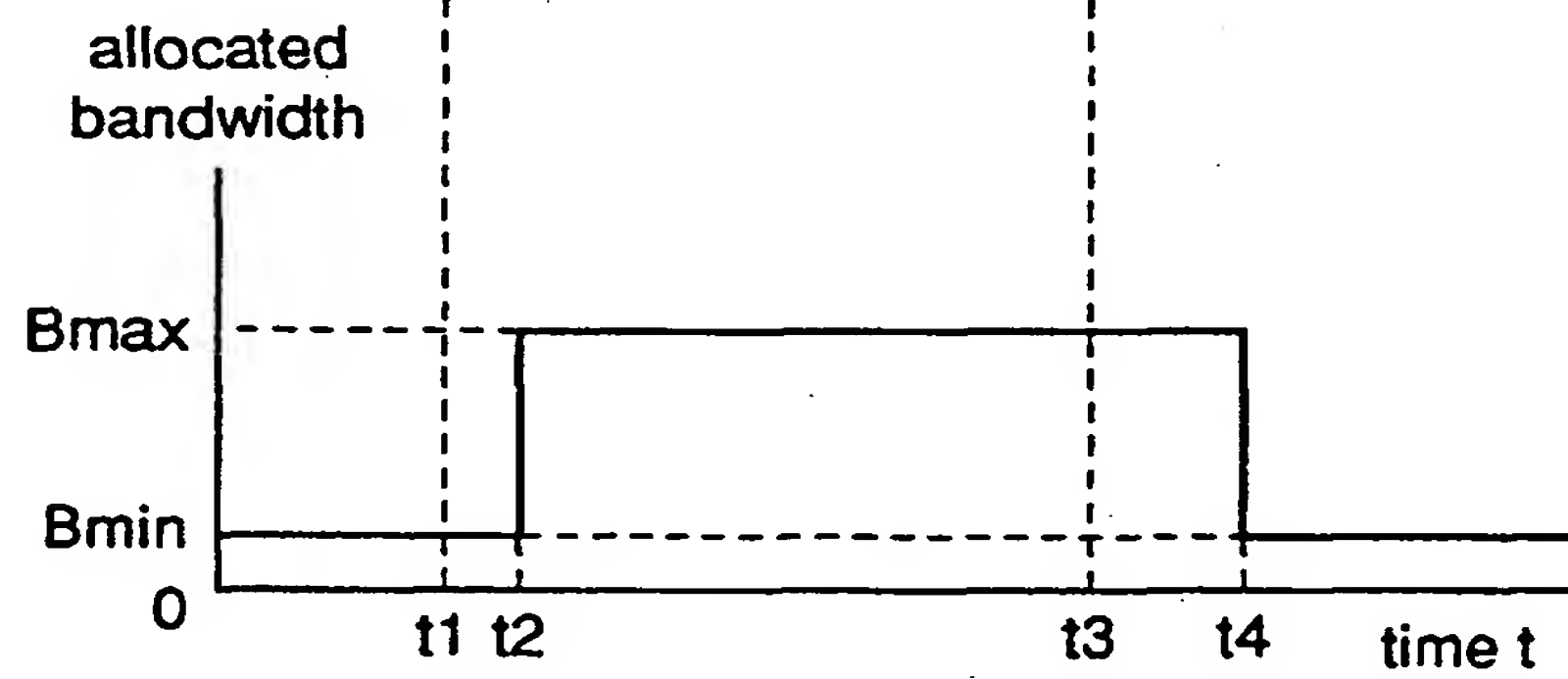


Fig.4

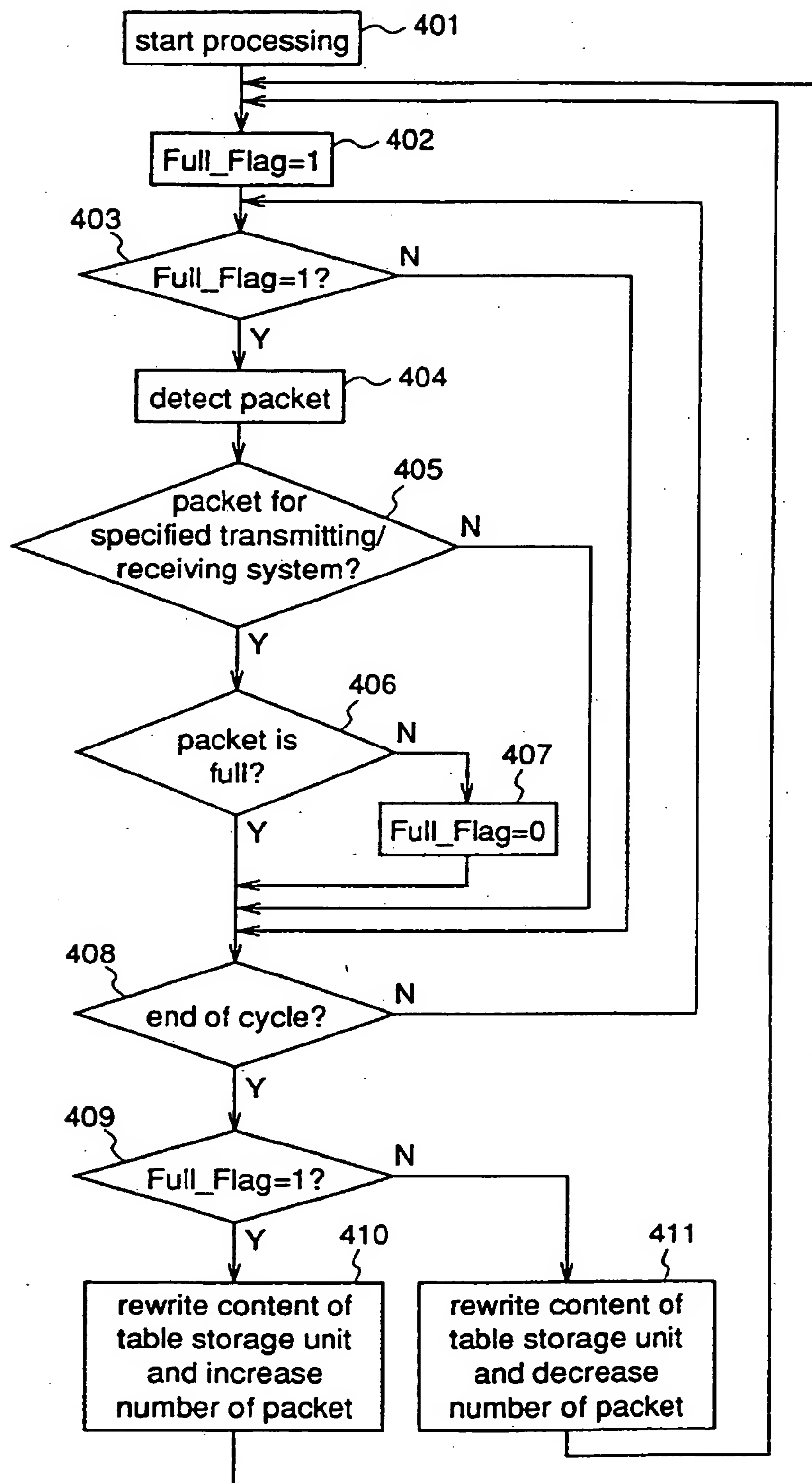


Fig.5

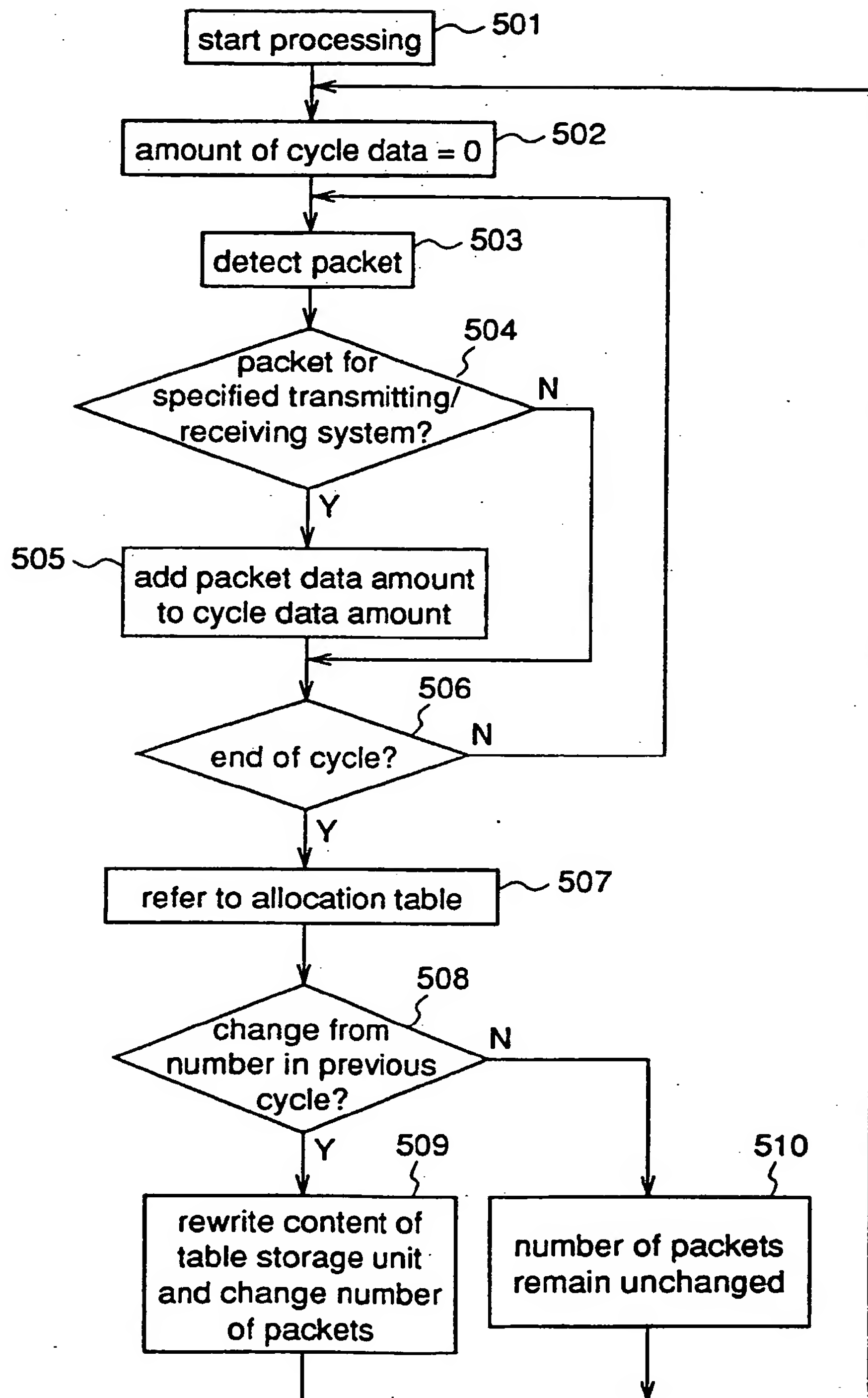
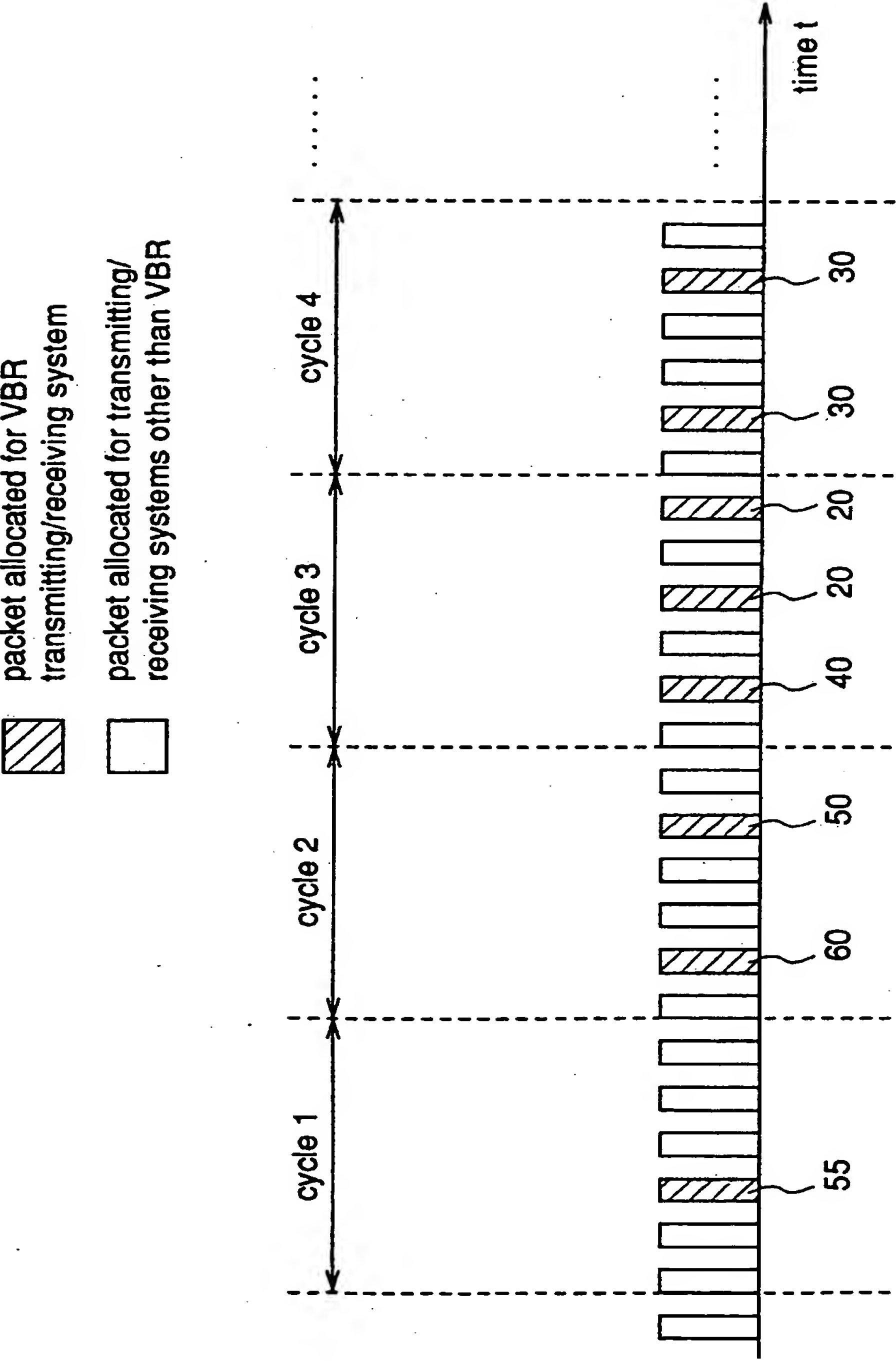


Fig.6

total data amount in cycle	number of allocated packets
0~50	1/cycle
51~100	2/cycle
101~150	3/cycle
151~200	4/cycle

Fig.7



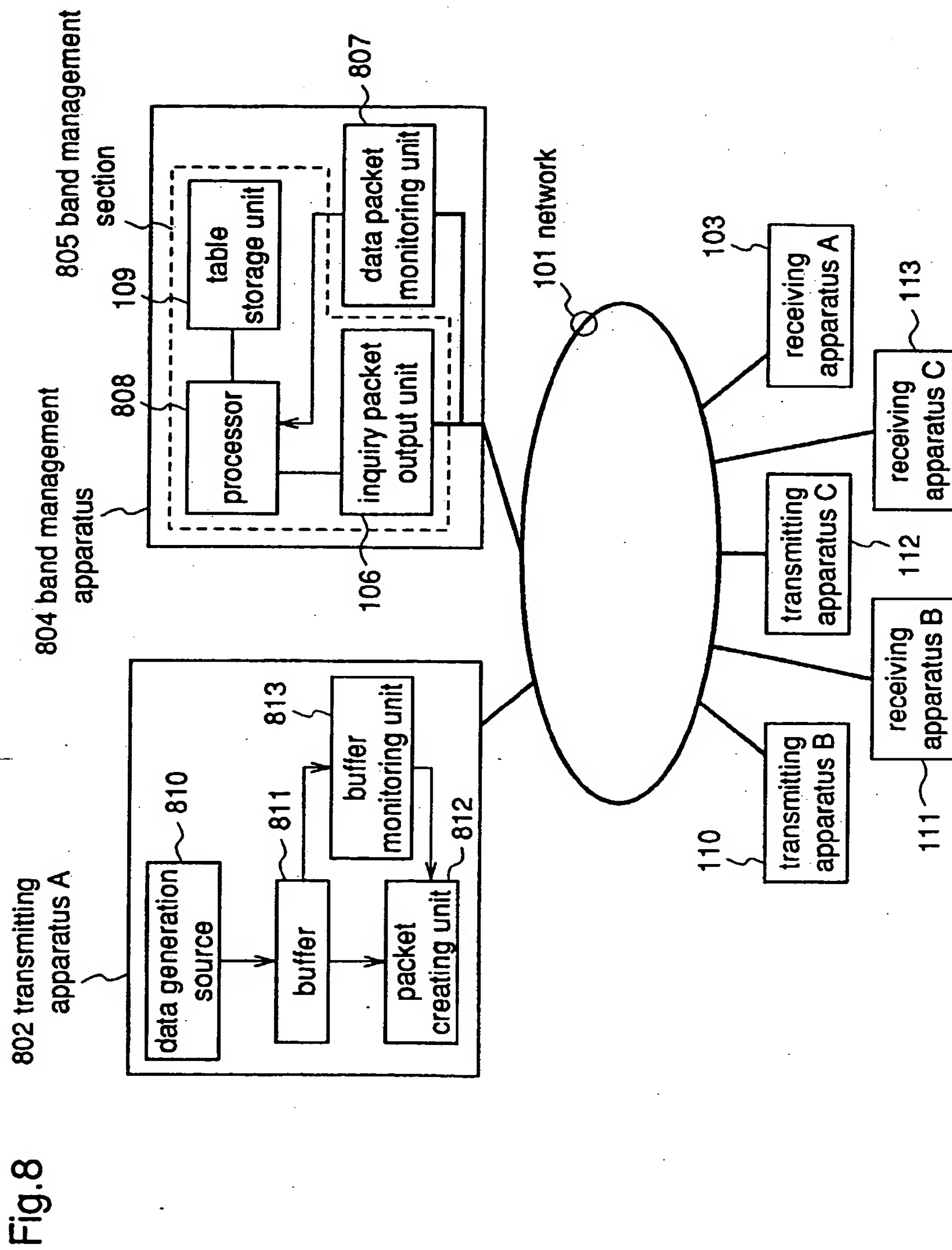


Fig.9

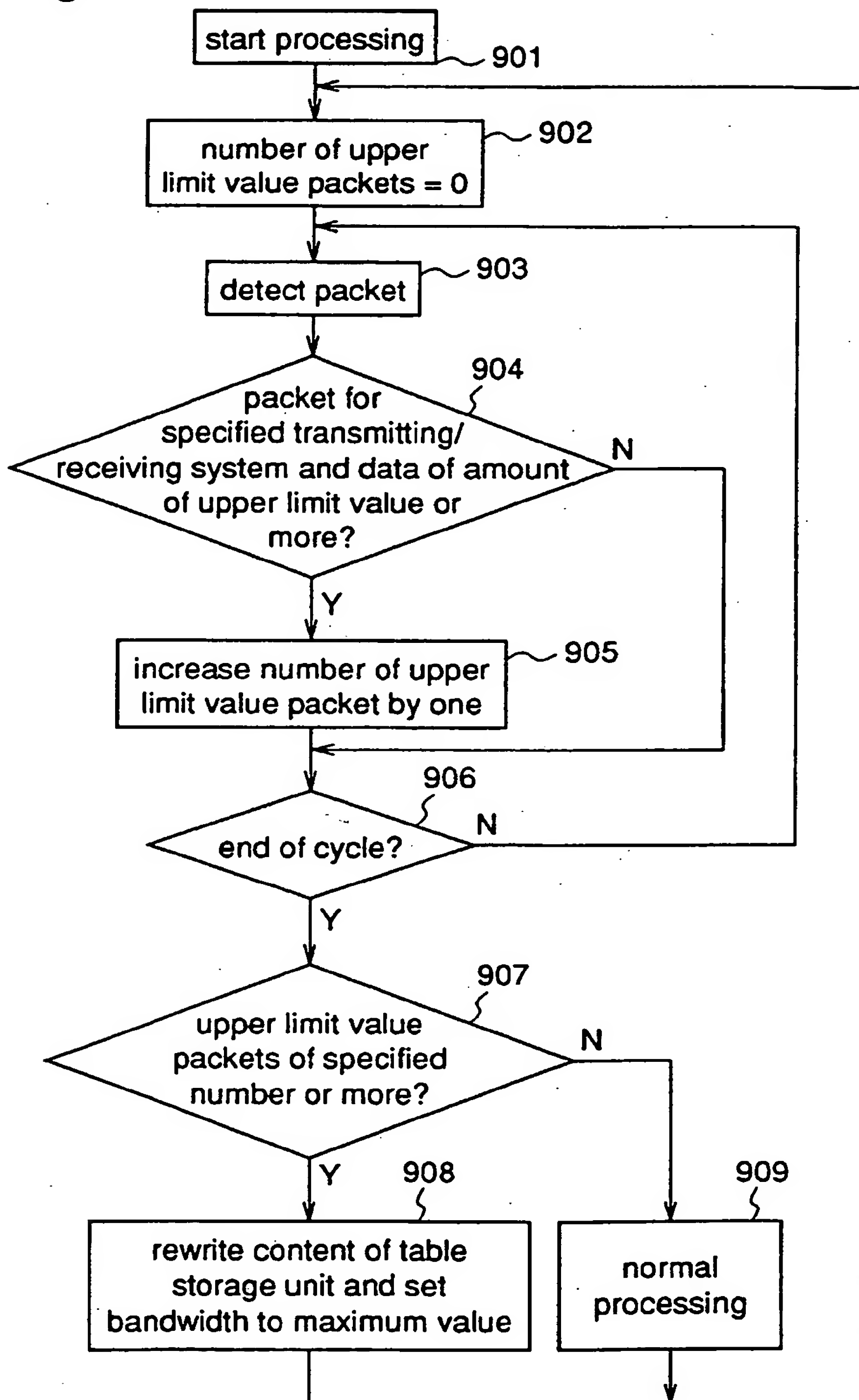


Fig.10 Prior Art

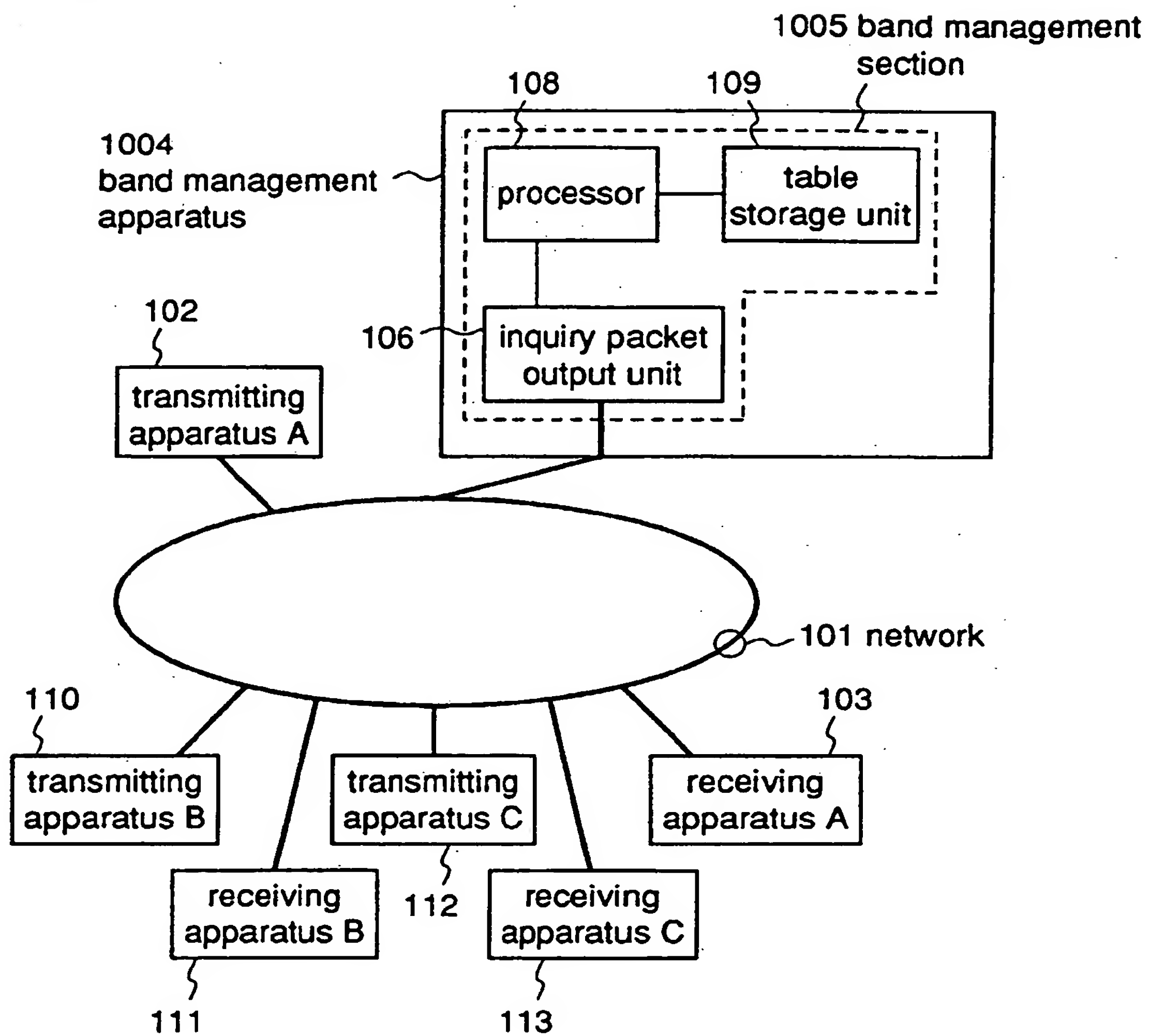


Fig.11

1	transmission source ID	receiving destination ID
2	transmission source ID	receiving destination ID
3	transmission source ID	receiving destination ID
4	transmission source ID	receiving destination ID
⋮	⋮	⋮
N	transmission source ID	receiving destination ID

Fig.12

1	ID of transmitting apparatus A	ID of receiving apparatus A
2	ID of transmitting apparatus B	ID of receiving apparatus B
3	ID of transmitting apparatus A	ID of receiving apparatus A
4	ID of transmitting apparatus C	ID of receiving apparatus C
5	ID of transmitting apparatus A	ID of receiving apparatus A
6	ID of transmitting apparatus B	ID of receiving apparatus B

Fig.13 Prior Art

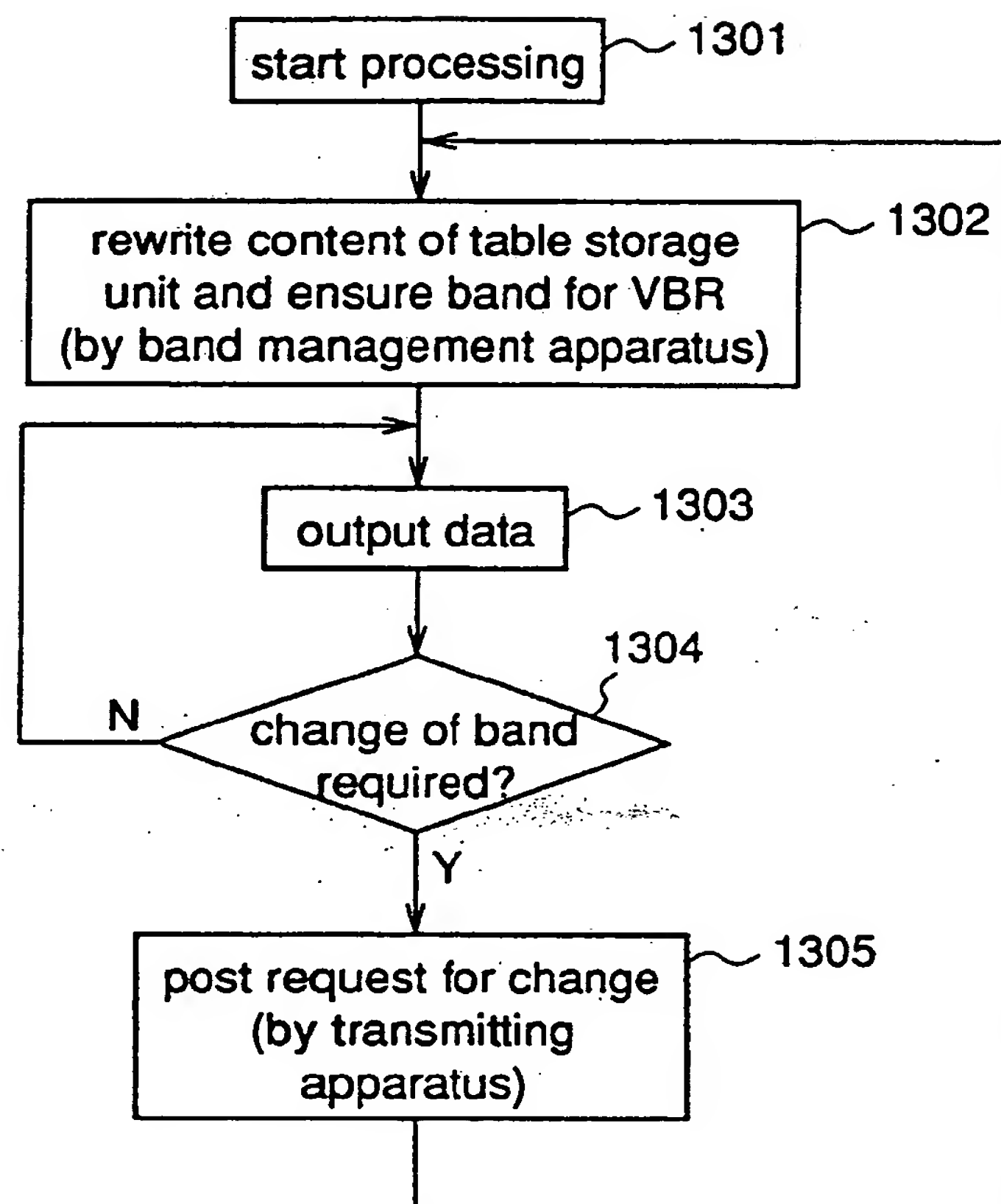


Fig. 14

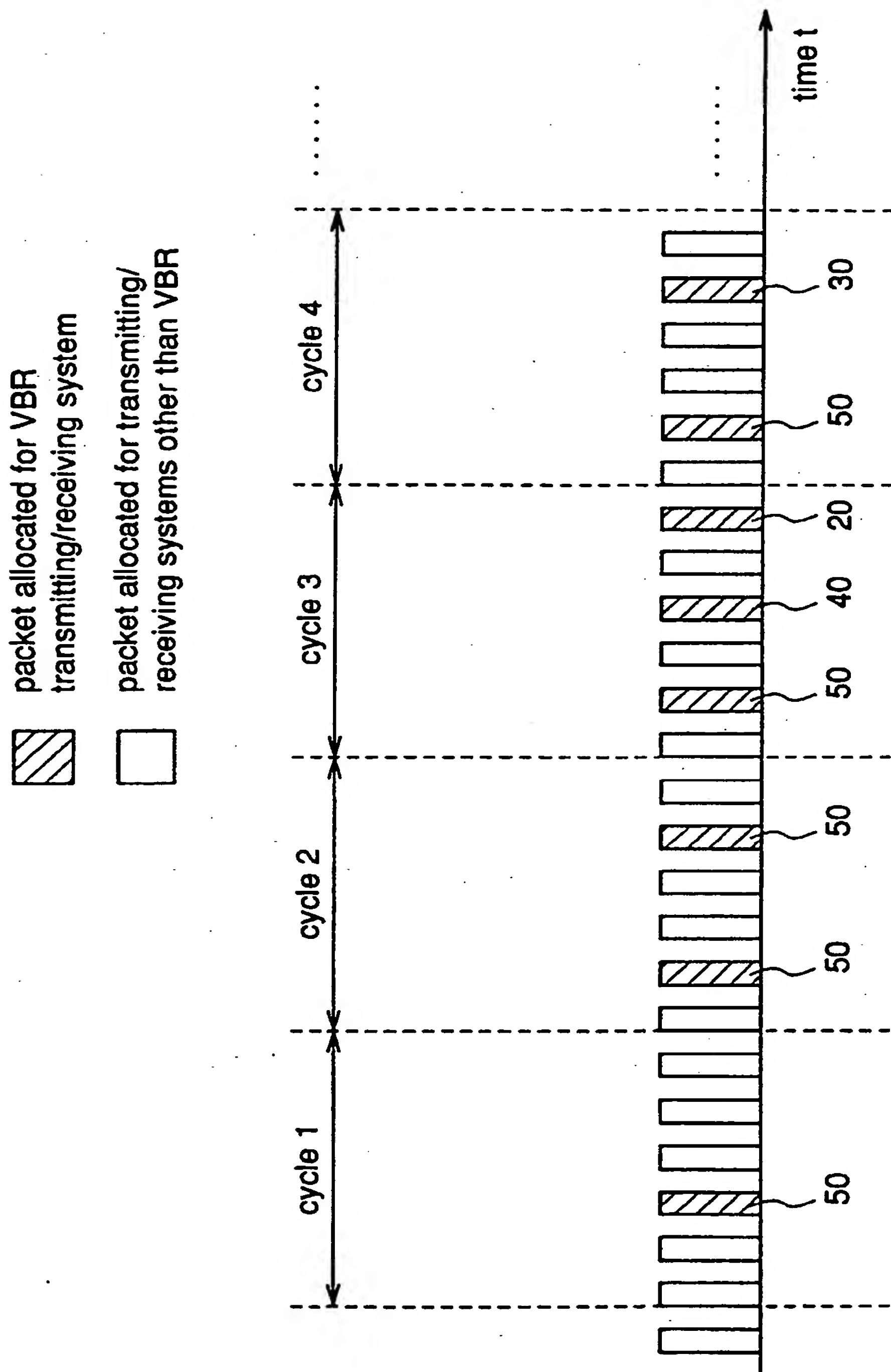
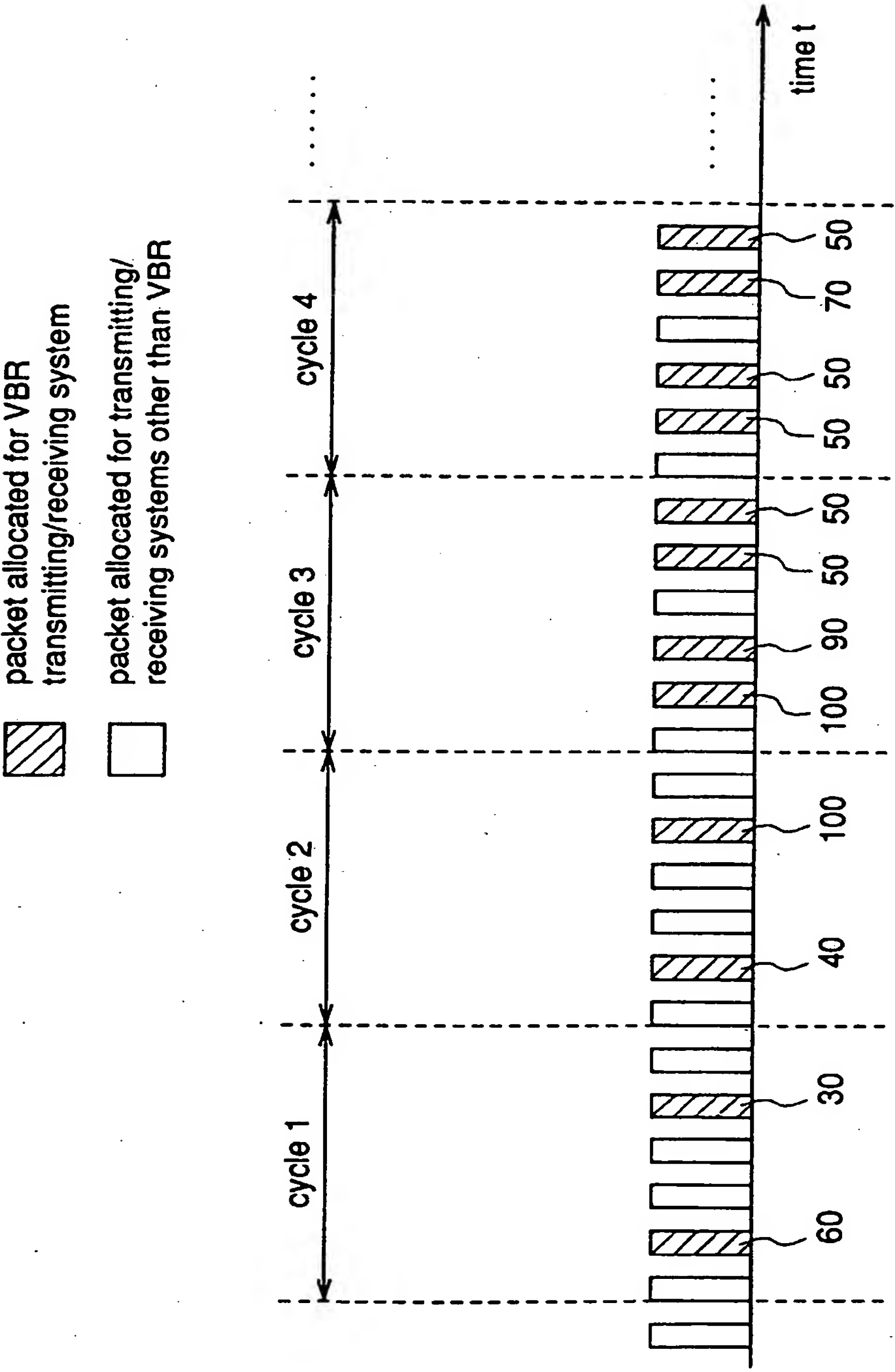


Fig.15





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EUROPEAN SEARCH REPORT

Application Number
EP 99 10 0887

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A	EP 0 817 428 A (OKI ELECTRIC IND CO LTD) 7 January 1998 * abstract * * column 4, line 9 - line 30 * * column 4, line 48 - line 52 * * column 7, line 5 - line 50 * * column 9, line 10 - line 28 * * figures 2,6,8 *	41 1-3,5,8, 10-13, 15,19, 20, 22-24, 26,29, 31-34, 36,40	H04L12/56 H04Q11/04
A	EP 0 814 585 A (IBM) 29 December 1997 * abstract * * page 8, line 21 - line 34 * * page 12, line 6 - page 14, line 18 * * figures 1,4,6,8 *	1,3-6,8, 11, 13-16, 20,22, 24-27, 29,32, 34-37,41	<div>TECHNICAL FIELDS SEARCHED (Int.Cl.6)</div> H04L H04Q
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 28 April 1999	Examiner Masche, C
<div>CATEGORY OF CITED DOCUMENTS</div> <div> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document </div>			

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EUROPEAN SEARCH REPORT

Application Number
EP 99 10 0887

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 8)
A	<p>EP 0 275 678 A (AMERICAN TELEPHONE & TELEGRAPH) 27 July 1988</p> <p>* abstract *</p> <p>* column 7, line 45 - line 56 *</p> <p>* column 9, line 45 - column 11, line 8 *</p> <p>* figures 1,5 *</p>	<p>1,3,4,6, 9,11,13, 14,16, 18,21, 22,24, 25,27, 30,32, 34,35, 37,39, 41,42</p>	
A	<p>EP 0 800 294 A (ALCATEL BELL NV) 8 October 1997</p> <p>* abstract *</p> <p>* page 3, line 56 - page 5, line 29 *</p> <p>* figure 2B *</p>	<p>1,3,8, 11,13, 20,22, 24,32, 34,41</p>	
The present search report has been drawn up for all claims			<p>TECHNICAL FIELDS SEARCHED (Int. Cl. 6)</p>
Place of search BERLIN		Date of completion of the search 28 April 1999	Examiner Masche, C
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone</p> <p>Y : particularly relevant if combined with another document of the same category</p> <p>A : technological background</p> <p>O : non-written disclosure</p> <p>P : intermediate document</p> <p>T : theory or principle underlying the invention</p> <p>E : earlier patent document, but published on, or after the filing date</p> <p>D : document cited in the application</p> <p>L : document cited for other reasons</p> <p>& : member of the same patent family, corresponding document</p>			

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